"FUNCTIONAL OUTCOME OF PROXIMAL HUMERUS PLATING IN DISPLACED PROXIMAL HUMERUS FRACTURES"

Dissertation submitted in

Partial fulfilment of the regulations required for the award of

M.S. DEGREE

In

ORTHOPAEDIC SURGERY – BRANCH II

THE TAMILNADU

DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI

APRIL 2016

COIMBATORE MEDICAL COLLEGE

COIMBATORE-641014

CERTIFICATE

This is to certify that the dissertation entitle "**Functional outcome of Proximal Humerus Plating in Displaced Proximal Humerus Fractures"** is a record of bonafide work done by **Dr.R.RAGAVANANDAM** in the Department of Orthopaedics, Coimbatore Medical College, Coimbatore under the guidance and supervision of **Dr.S.ELANGOVAN, M.S.,D.Ortho.,** Professor, Department of Orthopaedics, Coimbatore Medical College and submitted in partial fulfilment of the requirements for the award of M.S. Degree (Branch II) in Orthopaedic Surgery by The Tamilnadu Dr. MGR Medical University, Chennai.

Guide: Head of the Department

Dr.S. ELANGOVAN, M.S.,D.Ortho.,

The Professor & Head of the Department,
Department of Orthopaedics,
Coimbatore medical college,
Coimbatore.

Dr.S.EDWIN JOE M.D.,B.L.,

The Dean,
Coimbatore medical college,
Coimbatore.

DECLARATION

I hereby declare that the dissertation entitled **"Functional outcome of Proximal Humerus Plating in Displaced Proximal Humerus Fractures"** is a bonafide research work done by me in the Department of Orthopaedics, Coimbatore Medical College during the period from July 2014 to July 2015 under the guidance and supervision of Dr.S.ELANGOVAN, MS., D.Ortho., Professor, Department of Orthopaedics & Traumatology, Coimbatore Medical College.

This dissertation is submitted to The Tamilnadu Dr.MGR Medical University, Chennai towards the partial fulfilment of the requirement for the award of M.S., Degree (Branch II) in Orthopaedic Surgery. I have not submitted this dissertation on any previous occasion to any University for the award of any Degree.

Place: Coimbatore
Date: Dr.R RAGAVANANDAM.

ACKNOWLEDGEMENT

To begin with, I thank the Almighty in making this project a successful one.

I express my deep gratitude to **Dr.S.EDWIN JOE M.D.,B.L.,** Dean, Coimbatore Medical College, for permitting me to undertake this study.

I express my sincere gratitude to Prof **Dr. S. ELANGOVAN, M.S.,D.Ortho.,** Professor & Head of the Department of Orthopaedics & Traumatology, Coimbatore Medical College, for having suggested this topic for dissertation and for having rendered his valuable support and encouragement without which this project work would not have been feasible.

I also wish to record my sincere thanks to all Associate and Assistant Professors of Department of Orthopaedics & Traumatology, Coimbatore Medical College, for their constant support and encouragement throughout the work.

I thank all the technical staffs in the Department of Radiology , Coimbatore Medical College, for their sincere and timely technical assistance.

I express my heartfelt thanks to Department of Anaesthesiology, Coimbatore Medical College, for their constant support throughout the course of this study.

I express my heartfelt thanks and gratitude to my parents, my wife, my son , my brothers , sister and my friends for their extreme patience, constant support, encouraging words and source of strength all the way through this endeavour.

CONTENTS

LIST OF TABLES

LIST OF CHARTS

Coimbatore Medical College

COIMBATORE, TAMILNADU, INDIA - 641 014

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ETHICS COMMITTEE

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Name of the Candidate : Dr. R. Ragavanandam.

Course : M.S. Orthopaedics

Period of Study : 2013 - 2016

College : Coimbatore Medical college

Dissertation Topic : A prospective observational study - functional outcome of PHILOS plating in displaced proximal humerus fractures.

The Ethics Committee, Coimbatore Medical College has decided to inform that your Dissertation Proposal is accepted / ~~Not accepted~~ and you are permitted / ~~Not permitted~~ to proceed with the above Study.

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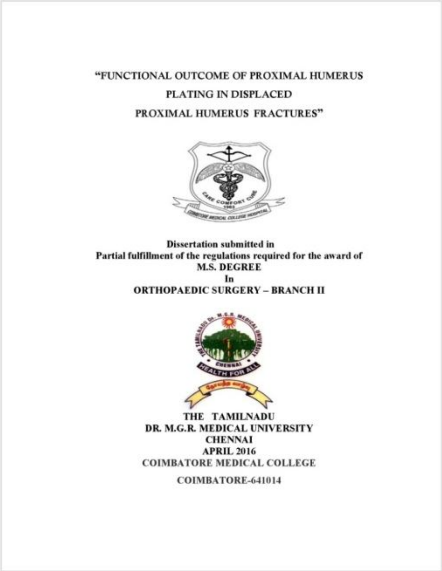

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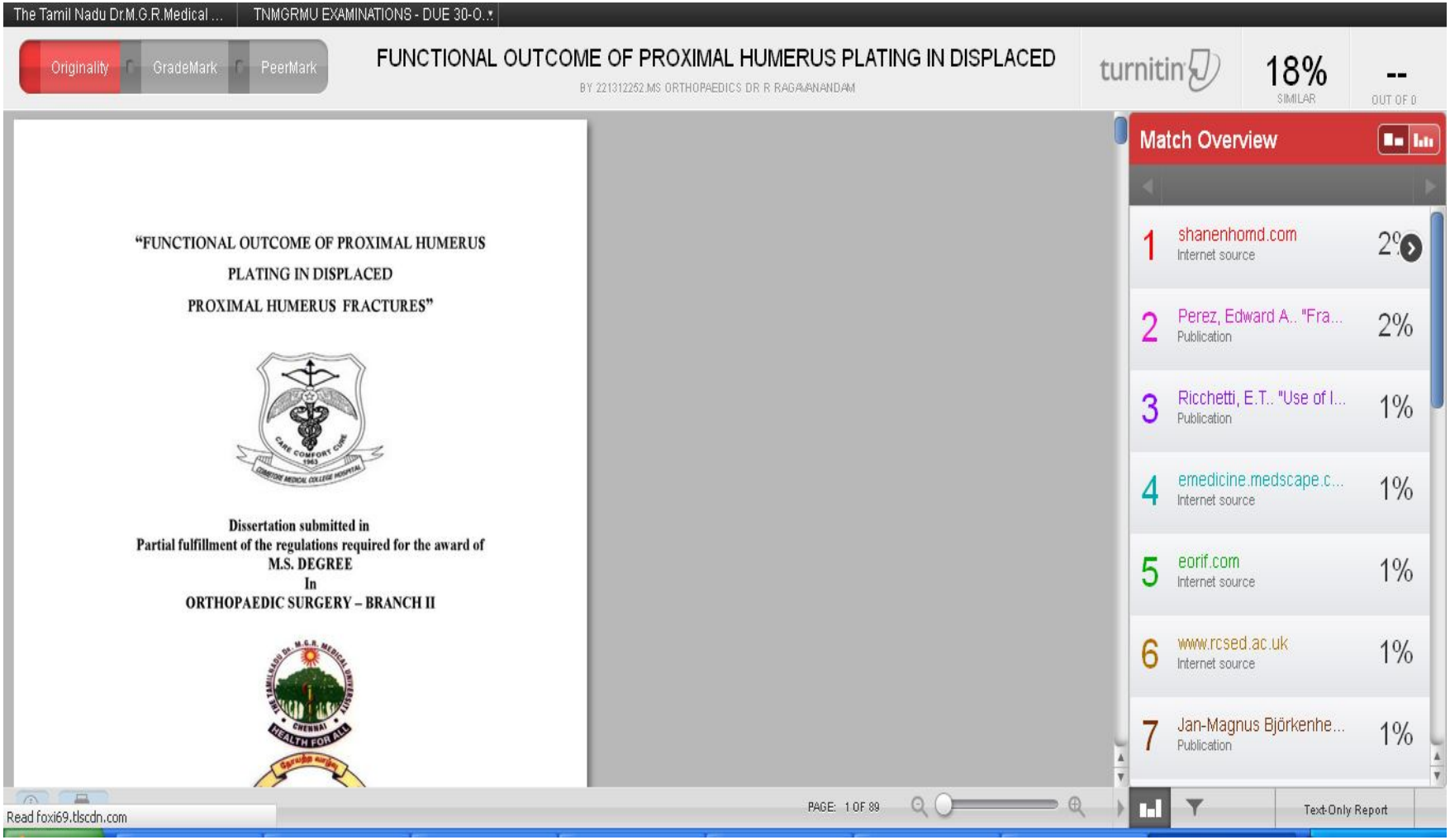
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INTRODUCTION

Fractures of the proximal humerus comprise nearly 4% of all fractures and 26% of fracture of humerus.[1] They are the commonest fractures in elderly population, which ranks the third and the first and second being, hip and distal radius fractures respectively. Proximal humerus involves head, greater tuberosity , lesser tuberosity and proximal one fourth of the shaft. Mostly common in elderly patients due to osteoporosis and less frequently in young adults due to high energy trauma.[2] Usually high energy trauma associated with dislocation .These fractures challenge the treating orthopaedician because of its osteoporotic quality in the elderly people and the deforming forces of the muscles attached. Most of proximal humerus fractures, in younger as well as in the elderly patients , are stable & slightly or non displaced , can be treated non operatively.[3] These comprise nearly 80% of proximal humerus fractures. The rest of 20% requires surgical fixation either because they needs better shoulder mobility or because their fracture is more severe. Neer's classification distinguishes between the number of displaced fragments with displacement defined as greater than 45 ° of angulation or > 1 cm of separation . These type of fractures require stable fixation. There are different types of fixation for proximal humerus fracture like k-wires, screw fixation, T-buttress plate , conventional plate , locking plate and prosthetic replacement. Every fixation has its own complication. The proximal humerus with poor cancellous bone quality especially in older patients, results in high risk of

failure of fixation with conventional plating system.[4,5,6] The PROXIMAL HUMERUS INTERNAL LOCKING SYSTEM (PHILOS) plate has been introduced to reduce these complications especially in older osteoporotic individual. Even minimally displaced fracture can be treated with philos plate to early mobilise the fracture thereby to avoid shoulder stiffness. Highly communited 3 & 4 parts fractures can be reconstructed with rotator cuff sutural ties with plate and thereby enhance the functional out come. This study enlightens the functional outcome of management of the fracture of humerus involving the proximal part, with PHILOS plate.

AIM & OBJECTIVES

AIM OF THE STUDY

The aim of study is to analyse the functional outcomes of patients with proximal humerus fracture with philos plate fixation.

OBJECTIVES

1. To evaluate the functional outcome of Proximal Humerus Locking Plate for displaced fracture of proximal humerus .

2. To improve stability in osteoporotic humeral bones.

3 To preserve the biological integrity of the humeral head and to secure an anatomical reduction with multiple locking screws with angular stability .

REVIEW OF LITERATURE

1. Jin-Qi Song & colleagues in 2015 compared the effect of operative vs. nonoperative management for comminuted proximal humerus fractures in elderly persons. Out of 287 patients, 144 patients (50.17%) were managed nonoperatively, 20 patients (6.97%) underwent tension band fixation, 55 patients (19.16%) were treated with locked plate, and 68 patients (23.69%) had undergone hemiarthroplasty. Mean follow-up range varied from 12–50 months. Results showed no marked difference in post-operative Constant scores and DASH scores, but conservative treatment showed superior results compared to operative treatment.

2. Rizwan SHAHID & colleagues in 2008 evaluated the final outcome of proximal humeral fractures (2part-11, 3part-11 and 4part -8) treated with the PHILOS plate.Out of fifty patients, 5 patients died and four were lost to follow-up. Mean follow-up duration was 22 months. Radiological union was achieved within 8 weeks in 40 patients . Complication in < 1%. Younger & male patients gave better result than female & elderly patients.

3. Moonot et al showed in 32 patients with displaced 3 or 4-part fractures of the proximal humerus were treated by PHILOS plate. There was no significant difference in final outcome when comparing patients above 60 years (56%) with below 60 years (44%). They concluded that early mobilisation is safe & trustable in young patient with solid bone stock.

4. Murray et al in 2011 stated that the management of the smaller & more communited and unstable fractures is more difficult to fix and new locking plate have greatly being used in fracture and assured the benefit.

5. Sivanandha & colleagues in 2014 tested the efficacy and functional outcome of locking compression plate in proximal humerus fractures in 30 patients for one year and concluded that the locking compression plate is mechanically and biologically an advantageous implant in proximal humeral fractures to mobilise early in comminuted fractures and in elderly patients.

6. AA Martineza & colleagues in 2009 evaluate the final outcome of Philos plate fixation for proximal humerus fractures in 31 men & 21 women with follow up of 18 months . All fractures healed with good functional outcome, except in one (malunion) with mean constant score of 80. They concluded that the Philos plate is good device of fixation in treating proximal humeral fractures.

7. MA Fazal & colleagues assessed the clinical outcome of Philos plate fixation for displaced fracture of proximal humerus. Out of 27 patients, followed up 13 months. All have satisfactory outcome & union except one who had fracture collapse and screw penetration of the humeral head at one & half month. Later development of non-union and avascular necrosis were evidented. The mean score was 70. They concluded that this locking plate provided stable fixation of fracture , less metal work problems and enabled early mobilisation to achieve satisfactory functional outcome.

8. Yong Girl Rhee et al in 2014 , 24 patients were evaluvated for final clinical outcome and its complications. Anatomical reduction of medial cortex buttress obtained in 16 patients were compared with non anatomical reduction in 8 patients. They concluded that indirect reduction & locking plate internal fixation for acute fractures result in good bony union and better fuctional outcome.

9. PATIL et al in 2012, 50 patients (18 - 3parts ; 32 - 4 parts) were treated with Philos plate. The mean score was 80 (range, 41 – 100). Complications of this study were osteonecrosis - percent, malunion - 0.5 percent, Axillary nerve njury - 0.5 percent and impingement syndrome - 0.5 percent. The most significant factor for better outcome is proper acceptable anatomical reduction, which is easily obtained by locking plate because of its multiaxial screw alignment. It is a good and promising tool for all ages with proximal humerus fracture without complications..

10.Manjeet et al in 2015, 20 patients (8- 2parts:12 -3parts) were managed by Philos plate and were followed for 23.2 months. Average Constant Murley Score at final follow up was 84.75 ± 11.6. 85% patients had very good and good fuctional results. No patient had poor functional results. They concluded that the Proximal humeral locking plate is an excellent implant in Neer's fractures of the proximal humerus. Complications can be minimized by meticulous surgical technique and proper placement of screws and plate. In

case of medial comminution, use of PHILOS with placement of medial support screws and bone grafting should be preferred to prevent varus collapse.

11.Rather et al in 2014, case series of 25 cases (21 male and 4 female ; 4 - 4part fracture, 12- 3 part fracture and 9 - 2 part fractures) of displaced proximal humerus fractures operated with the proximal humerus locking plate. Mean union time was 15.6 weeks. Results were excellent/good in 20, fair results in 2 and poor results in 2 patients.

12. Dr.K.Venkateswarlu & colleagues , concluded that locking plate is superior to other implant fixation in 2 & 3 part fractures of Neer's classification. however it has doubtful result in 4 part fracture. In 20 patients they had good result in 2 & 3 part fractures. Functional evaluation was based on pain relief , range of motion & functional outcome.

13. Bansal et al in 2015, in 25 patients (11- 2 parts, 11-3 parts and 3- 4 parts) with outcome of excellent in 16%, good in 44%, fair in 16% while poor in 24%. With their experience, they concluded that the chance of complications and re-operation is relatively high. Steep learning curve and surgeons experience are considered to be more essential for successful operative treatment.

14. Sharma et al in 2015, concluded that with well advancement of technology, philos plate gives good result in displaced proximal humerus fractures and minimal complications.

PROXIMAL HUMERUS FRACTURES

Anatomy [7,8]

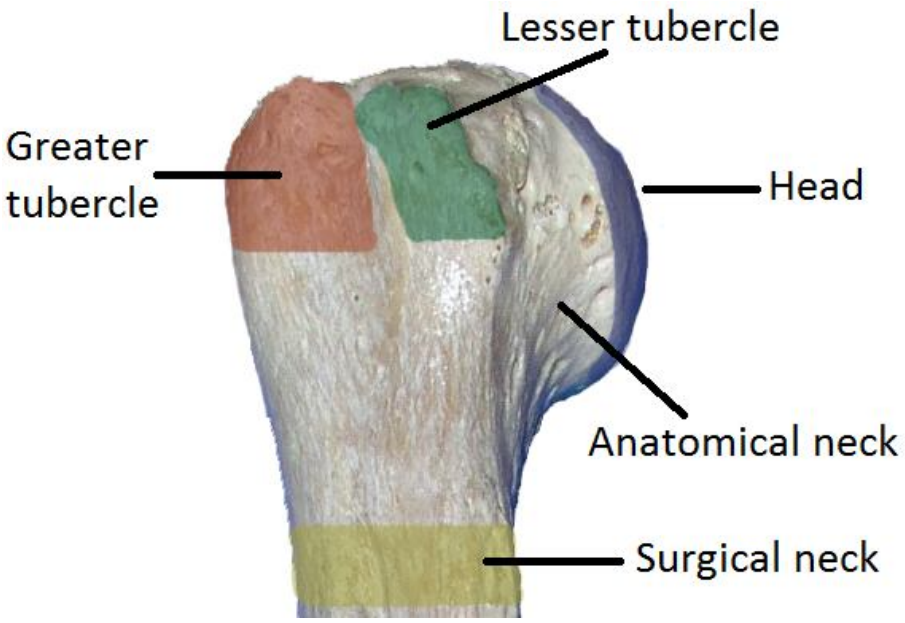
The proximal humerus consists of

1.Head,

2.Neck - anatomical & surgical

3.Tubercles - the greater and lesser tubercles &

4.Shaft



Head :

The humeral head is a spheroidal bony structure (strictly ovoidal) which has smooth articular surface lined by hyaline cartilage. In neutral position, it is faced medially, backwards and upwards in relation to glenoid of the scapula.

The surface of the joint is larger than the glenoid cavity, and only a portion of it is in contact with the cavity in any one position of the arm.

The humeral head is constricted below and is called as the **anatomical neck,** in contrast to a part constriction below the greater & lesser tubercles called the **surgical neck** where fracture is more common.

Anatomical Neck :

It is an oblique part of proximal humerus, which forms an angle with the shaft. It is a groove directed downwards from medial to lateral just below the circumference of humeral head.

Surgical Neck :

The narrow line separating the upper end of the humerus from the shaft is called the surgical neck. It is a diaphyseal expand ends in a metaphyseal flare just below the greater and lesser tuberosities. Common site for fracture.

Greater Tuberosity :

The greater tuberosity is a prominence that forms the lateral part of upper end of humerus. Its upper surface being round has three impressions for the insertion of Supraspinatus, Infraspinatus, Teres minor from above downwards. The lateral surface of the greater tuberosity is convex, rough, presents with numerous vascular foramina and is covered by the thick, bulky deltoid, which presents the normal spherical contour of the shoulder. A part of the subacromial bursa may cover the upper part of this area and separate it from deltoid.

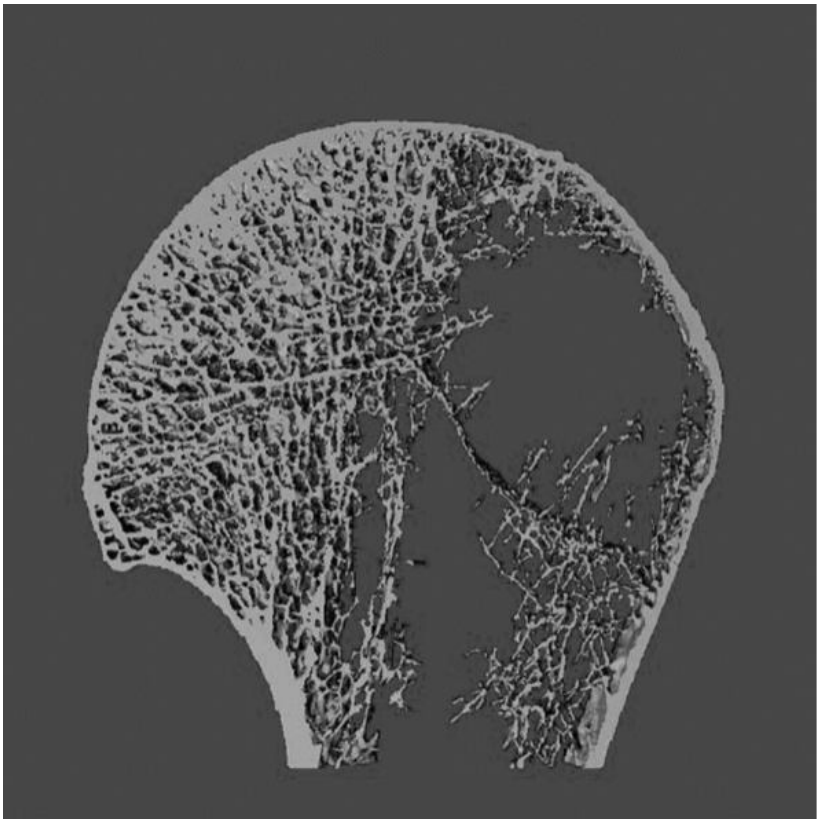
Lesser Tuberosity :

The lesser tuberosity is a prominence, situated just anterior and beyond the anatomical neck. It is directed medially and forward. An impression over it provides the insertion for Subscapularis. In it's lateral margin it gives attachment for the transverse ligament of the shoulder joint.

The tuberosities are separated from each other by a deep impression called the **intertubercular groove.** It is also called the bicipital groove, which contains the long tendon of the Biceps brachii and anterior humeral circumflex artery which supplies the shoulder-joint. It runs obliquely distally, and ceases near the junction of the upper with the middle third of the bone. It gives insertion to Latissimus dorsi. The elevation on either side of the bicipital groove is called the **bicipital ridge**, which attaches the pectoralis major laterally and teres major medially.

Bone Density of Humeral Head

The distribution of bone within the proximal humerus is not uniform. The subchondral bone under the articular surface is dense cancellous bone, with bone mineral density decreasing progressively toward the geometric center of the humeral head and into the metaphyseal area of the surgical neck.[9] The overall bone quality is predicted by (1) cortical thickness of the proximal diaphysis[10] & (2) age of the patient.



Anatomic relationship

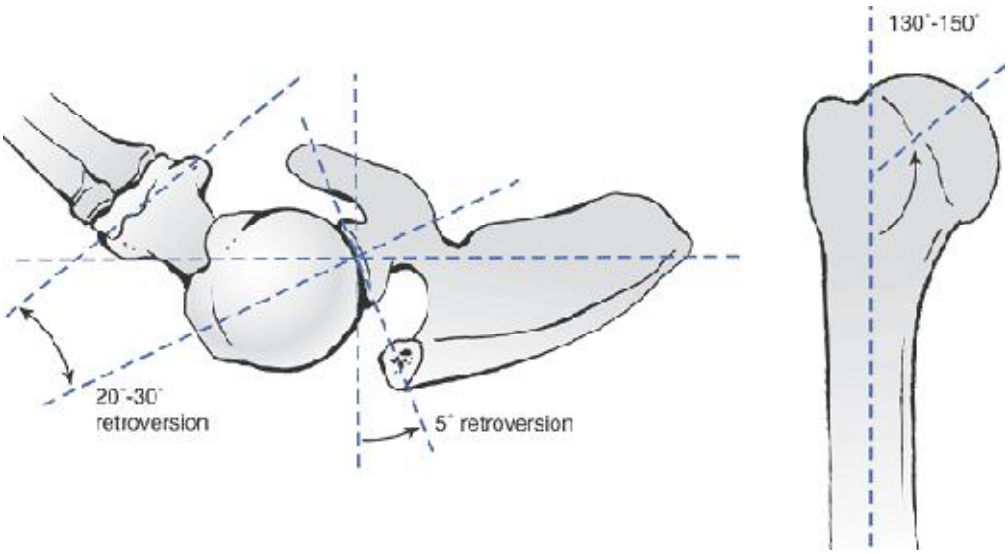
The proximal humerus is anatomically related to the shaft and it's tuberosities as follows:[11]

a	Retroversion, of head
b	Inclination angle of head
c	Translation of the head relative to the shaft
d	The relationship of the head to the greater tuberosity.

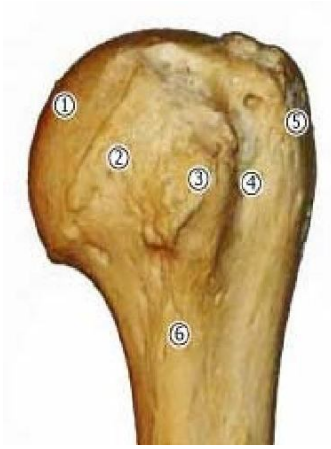
The articular segment is retroverted 30° relative to the arm. The range is from 0-69° and can vary from one side to the other.

Inclination of the articular segment also can vary. It range from 120-142°. [12]

The head segment can lie directly over the medullary canal but often is translated either posteriorly or medially. [13]

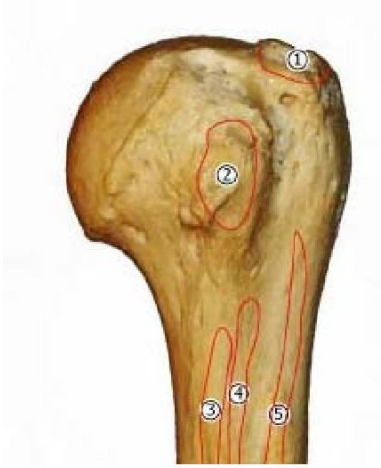


Proximal Humerus Anatomy



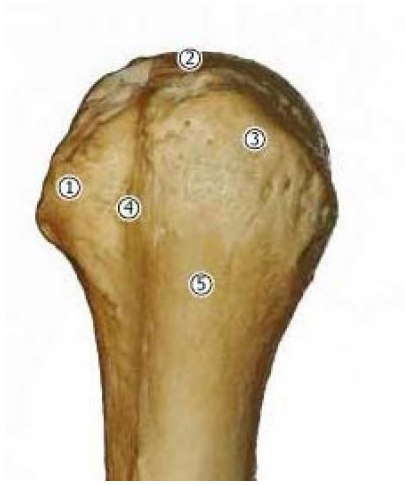
Proximal Humerus - Anterior view bony anatomy

1. Humeral head
2. Anatomic neck
3. Lesser tuberosity
4. Intertrubercular groove
5. Greater tuberosity
6. Surgical neck



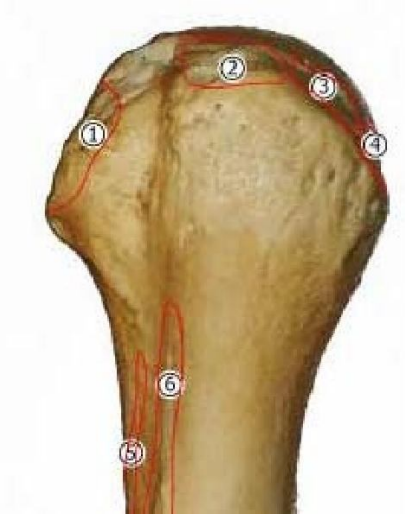
Proximal humerus - Anterior view muscular attachments

1. Supraspinatus
2. Subscapularis
3. Teres major
4. Latismus Dorsi
5. Pectoralis major



Proximal Humerus - Lateral view bony anatomy

1. Lesser tuberosity
2. Humeral head
3. Greater tuberosity
4. Intertubercular groove
5. Surgical neck

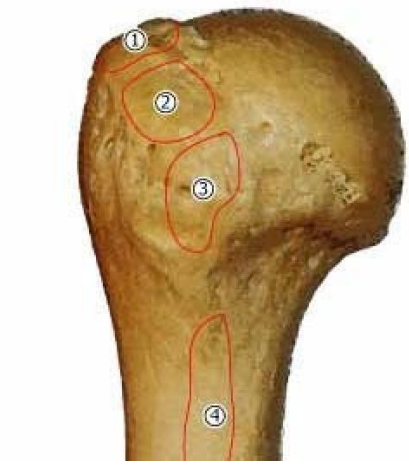


Proximal humerus - Lateral view muscular attachments

1. Subscapularis
2. Supraspinatus
3. Infraspinatus
4. Teres minor
5. Pectoralis major
6. Latissmus Dorsi

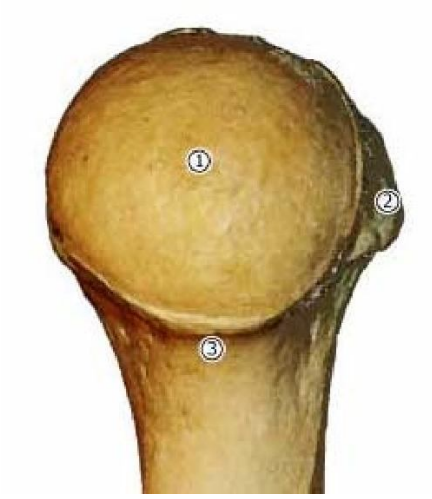
Proximal Humerus - Posterior view bony anatomy

1. Humeral head
2. Anatomic neck
3. Greater tuberosity
4. Surgical neck



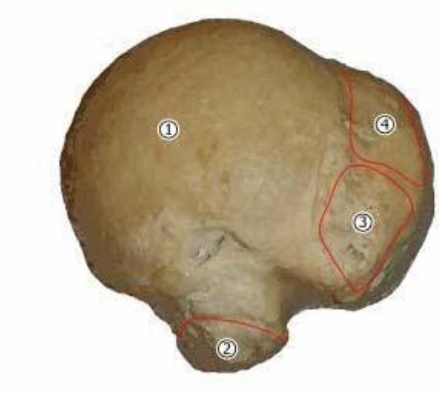
Proximal humerus - Posterior view muscular attachments

1. Supraspinatus
2. Infraspinatus
3. Teres minor
4. Triceps (lateral head)



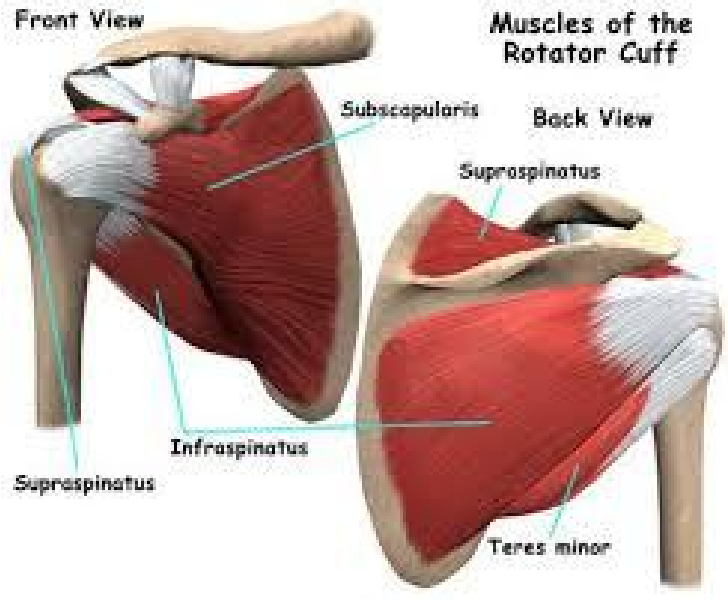
Proximal Humerus - Medial view bony anatomy

1.Humeral head
2.Lesser tuberosity
3.Anatomic neck



Proximal humerus Superior view-muscular attachments

1.Humeral head
2.Supraspinatus: anatomic footprint of the supraspinatus is 25mm from anterior to posterior and 12mm from medial to lateral.
3.Infraspinatus
4. Teres minor



Vascular Anatomy of Proximal Humerus[14,15]

The main blood supply from the axillary artery through its

1.anterior circumflex humeral artery (85%)

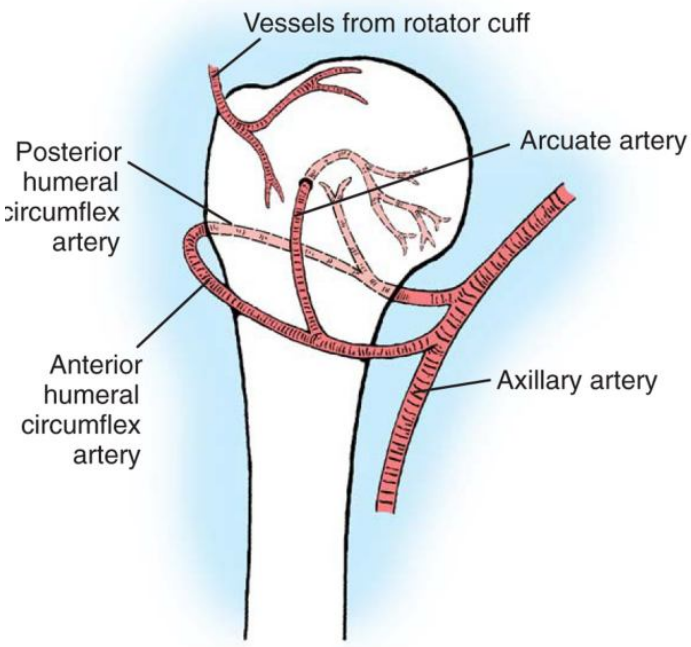
2.posterior circumflex humeral artery (15%)

which anastamose in the following regions:

a.medially in th quadrilateral space

b.laterally in the area of the greater tuberosity and

c.in the humeral head through the rich network of interosseous anastamose.



Anterior Circumflex Humeral Artery feeds the following region through

1) Lesser tuberosity and the

2) Majority of humeral head

through

a) Anterolateral ascending artery (lies in bicipital groove)

b) Intraosseous arcuate artery (just below articular surface)

Posterior Circumflex Humeral Artery

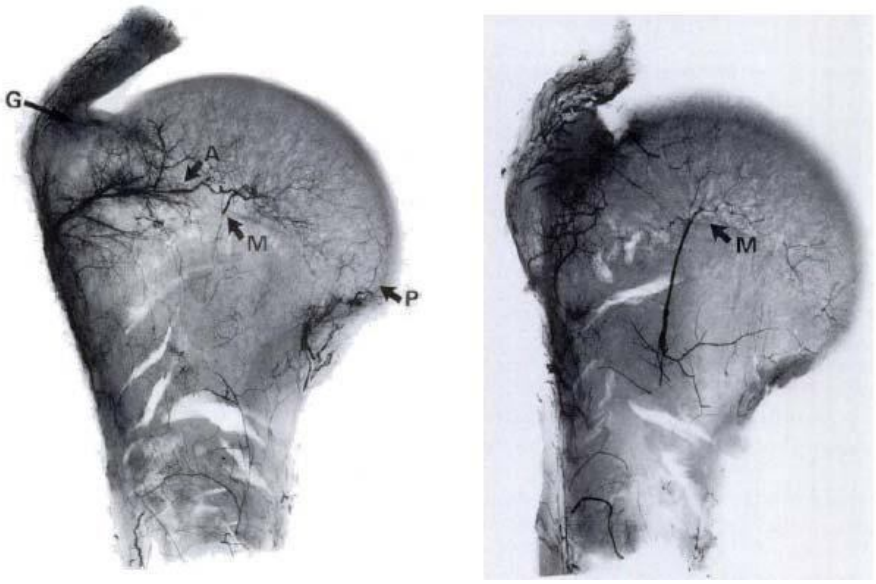
1)greater tuberosity and

2)posteromedial aspect of the head

It enters the head along the line of the capsular insertion in the anatomic neck posteriorly and inferiorly.

The prime source of vascularity to head is arcurate artery on medial aspect once major plexus of blood vessel are disturbed in four part fracture. The plexus included anterior circumflex humeral artery, metaphyseal artery and arteries of greater & lesser tuberosities.

The blood supply is usually compromised in case of four -part fractures. But in some special instances where posteromedial cortex is intact, such as impacted head of humerus and in valgus, the blood supply from posteromedial vessels is being retained. This is because the posteromedial cortex forms a bridge through which the vascularity of the head is maintained. Therefore avascular necrosis of head of humerus becomes a rare incidence. But when there is a discontinuity in the medial aspect of the neck, the chances of avascular necrosis is higher.[16,17,18]



Perfusion angiograms of the humeral head showing : the arcuate artery (A) the metaphyseal anastomosis (M) the posteromedial anastomosis (P) and the greater tuberosity anastomosis (G).

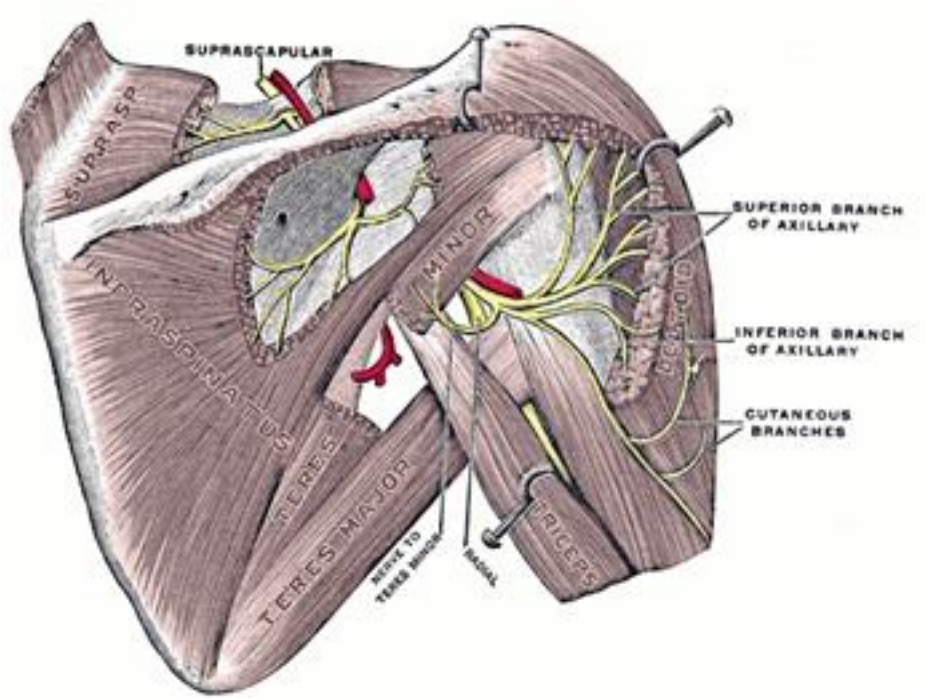
Nerve Supply

The main innervation from branches of the brachial plexus (C5-T1). It may be damaged by displaced fracture fragments or through traction injury. Conjoined tendons of the short head of biceps and coracobrachialis protects the trunks, divisions, cord & branches of brachial plexus during surgery. Conjoint tendon forms the medial extent of surgical exposure through the deltopectoral approach.

Musculocutaneous nerve can be injured by prolonged traction during surgery. This pierces the conjoined tendon approximately 6 to 8 cm distal to the tip of the coracoid process.[19]

The axillary nerve (C5-C6) is the main structure at risk during operative treatment of proximal humeral fractures. The nerve lies posterolateral to the lower subscapularis to enter the quadrilateral space, where it is an immediate inferior relation of the glenohumeral joint capsule.

Its posterior branch supplies the posterior deltoid and teres minor and provides sensation to the “badge area” of the upper arm.



Axillary Nerve - Muscular Innervation

The anterior branch winds around the surgical neck deep to the deltoid muscle and has a somewhat variable course.[20] It innervates the anterior and middle thirds of the deltoid but has no cutaneous branches.

Mode Of Injury :

The common mode of injury is fall on an outstretched, typically in an elderly osteoporotic female.[21]

In young patients, frequent cause is violent trauma associated with increased energy and the ultimate impact is very severe.

Other mechanisms include:

1.Abduction of shoulder beyond the limit in an osteoporotic individual, in which the further rotation is prevented by greater tuberosity.

2.Direct trauma, over proximal humerus [22]

3.Electrical shock or seizure.

4.Pathologic fracture of proximal humerus

Fracture Mechanism

The deforming forces of the muscular attachments to the fragments of the proximal humerus determines the fracture pattern.

1.Supraspianatus ,infraspinatus, and teres minor tendons inserted onto the greater tuberosity contribute to the typical posterior and superior displacement of this fragment. The rotator interval functions as a checkrein on the humeral head fragment and limits displacement of two-

part fractures and most three-part fractures. Functionally significant tears of the rotator interval are uncommon.

2.The pull of the subscapularis muscle tends to retract lesser tuberosity fragments medially. When the lesser tuberosity remains attached to the head fragment, the head fragment is rotated internally. Although the bone at the tendinous insertion tends to be very dense and strong, thus providing a potential site for fracture fixation, it is important when using suture fixation to remember that the tendons are even stronger than the bone.[23]

Deforming Muscle Forces

3. Pectoralis inserted on lip of bicipital groove hence fractured shaft displaced medially.

4. Deltoid insertion causes adbuction of the fractured proximal fragment.

It is difficult to fix osteoporotic bone with rigid implant because of poor quality of bone. Several studies have pointed out age is the most notable prognostic factor for implant failure and poor outcome after rigid surgical fixation of proximal humerus fractures. This is due to the comparison of bone quality and age with increasing degrees of osteoporosis. [24]

In general, two specific types of patients can be identified based on bone quality. In type 1, the patients are younger, as a result of greater trauma , there may be minimally displaced fractures or more comminution of dense bone. These individuals are better suited for rigid fixation due to good-quality bone.

In type 2 patients, the bone is more osteoporotic due to advanced age and decreased bone density, and usually less trauma is required to generate a fracture. These fractures are more often displaced than impacted, and for this reason appropriate reduction and fixation can be a challenge for the osteoporotic bone.

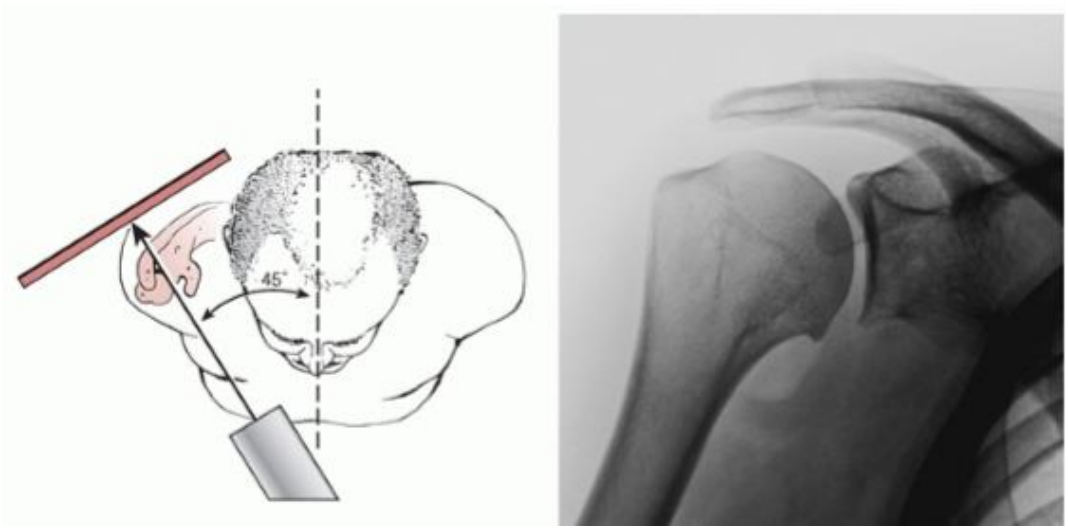
Radiological Evaluation

Radiological evaluation is necessary for classification of fractures and planning of operative treatment.

Routine views include Antero posterior, Lateral and Scapula Y view. These views may be more difficult and uncomfortable for patients.

Special view like velpeau view[25] or modified axillary view can be easy to take and comfortable for patient , that can be taken with arm in the sling.

The best fracture geometry is depicted if the orthogonal views are taken in the plane of the glenoid. Since the scapula is protracted on the chest wall, the anteroposterior view is usually obtained by tilting the x-ray beam approximately 45 degrees medial to the normal anatomic plane.



True anteroposterior view - the beam to be angled 45 ° from the sagittal plane.

Computed tomography scans provide the most reliable information and are helpful in evaluating of intraarticular fractures to assess the degree and nature of damage to the joint surface and in evaluating of fracture displacement, particularly the greater tuberosity and lesser tuberosity.

TREATMENT [26, 27]

Non Operative Treatment

Non Operative treatment is mostly preferable for

1. Elderly patients with osteoporosis
2. severe co-morbid conditions
3. minimally displaced fractures
4. Impacted fractures
5. one part fracture

Closed reduction of highly comminuted or displaced fractures are difficult to reduce and manage often results in poor functional results.[28,29]

Conservative treatment is maintained with a triangular sling or U slab/cast for 3 to 6 weeks. Wrist & Elbow movement is encouraged immediately to minimise the risk of stiffness and edema. Passive mobilisation is allowed after 2 weeks when the pain is reduced and when there is a evidence of radiological union.[30]

Operative Treatment

Surgery is indicated if more than one of the fracture fragments is displaced or angulated.

Indications for surgery:

1) More than 1 cm displacement of a fracture fragment,
2) Angulation of fracture fragments is 45° or greater,
3) Greater tuberosity avulsion fracture if displacement is 5 mm or more.
4) Two part surgical neck fracture, displaced 3 or 4 part fractures

However, other factors like quality of bone, orientation of fracture, and soft tissue injuries, the age of the patient, co morbid condition and the surgeon's skill in treating these injuries also have a tremendous effect on indications of surgical treatment.

Preoperative Planning

Preoperative planning and evaluation include patient history and clinical examination, radiographic evaluation and planning.

Key components of the history include the mechanism of injury as well as the patient's age, handedness, pre-injury shoulder function, occupation of patient, functional demands and co-morbidities.

Clinical examination of the shoulder includes type of fracture (open or closed), local signs of injury like tenderness, swelling, the position of the humeral head on palpation (i.e., located, subluxated, dislocated), active and passive shoulder range of motion (ROM), neurovascular status of the extremity, and associated fracture/injuries.

Radiological evaluation includes trauma series x ray, standard plain x rays of shoulder like AP view, axillary view and scapula view and special views like west point view & velpeau view.

Thin slice coronal and sagittal CT scans of the shoulder may be helpful when intra-articular involvement is doubtful, including articular comminution of the humeral head or suspected glenoid involvement, and when plain x rays do not show the fracture geometry clearly. The information obtained from both plain radiographs and CT regarding the characteristics of the fracture is vital in developing a surgical plan, which includes determining intraoperative reduction maneuvers and choosing the appropriate method of internal fixation.

Before planning for operative procedure , it is necessary to determine the vascularity of head, bone quality , choice of implant and method of fixation.

Humeral head ischemia can be predicted by **Hertel** radiographic criteria [(31)] - 1) <8mm of metaphyseal extension of the humeral head, 2) > 2mm of medial hinge distruption . Combination of both plus anatomical neck fracture have positive predictive value greater than 97%.

Bone quality can be predicted by cortical thickness of humeral diaphysis - cortical thickness of less than 4mm does not allow to have good screw purchase . Hence conservative treatment, transosseous suturing or hemiarthroplasty may be the better choice of treatment.

Implants and fixation methods

Minimally invasive techniques

i. Percutaneous Pinning or Screw fixation
ii. Minimally invasive Plating and intramedullary Nailing
iii. External Fixation

Open reduction internal fixation techniques

i. Transosseous suture fixation
ii. Plate - conventional T plate or LCP
iii. Intramedullary Nail - Polarus os polyaxial nail

Replacement Arthroplasty

i. Conventional Arthroplasty
ii. Reverse Shoulder Arthroplasty

Percutaneous Pinning

This method has an advantage of minimal injury to soft tissue and vascularity to humeral head. It is cheap and less expensive. But it demands adequate close reduction, satisfactory bone stock, lesser comminution and an intact medial cortex.

complications like loss of purchase, pin site infection and neurovascular damage are common. Only contraindication is metaphyseal comminution of fracture.

Percutaneous pinning

Minimally Invasive Plating and Intramedullary Nailing

This technique is similar to percutaneous pinning with same advantages and complications. Newer model of locked-plating and intramedullary nailing systems now for percutaneous insertion through small stab incisions. Proximal and distal screw insertion is performed

percutaneously using custom-made jigs. This technique is reserved for minimally displaced two-part surgical neck fractures with good bone stock, where the reduction is easily obtained.[32]

Transosseous Suture Fixation

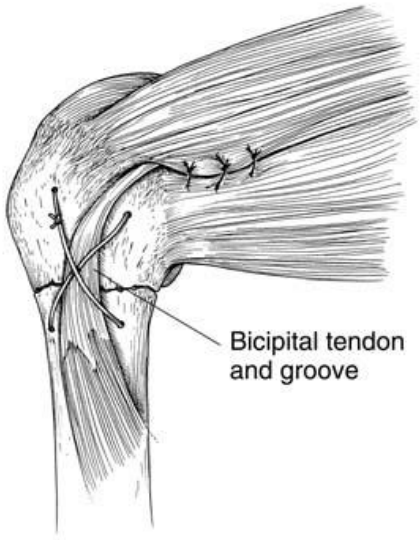
Ideal for isolated greater tuberosity fractures with displacement of >5mm. Also advocated for two-part surgical neck fractures and three-part proximal humerus fractures.[33,34,35]

Technique - Flatow et al

In lateral approach, strong nonabsorbable sutures are inserted under the supraspinatus tendon, and drill holes are created in the humerus to secure reduction of the greater tuberosity fragment.

Advantages

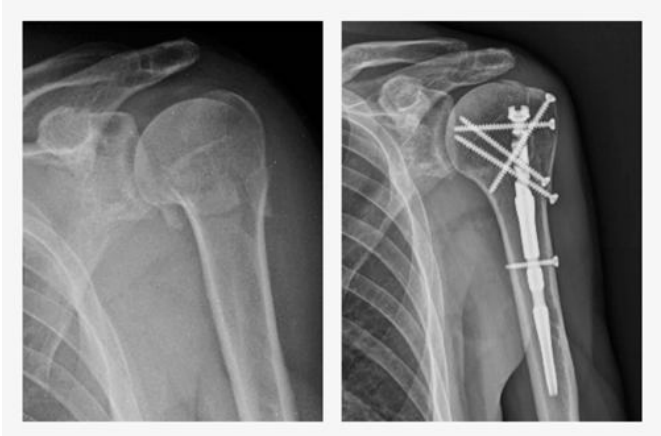
Low soft tissue damage
Less chance of avascular necrosis
Early passive joint mobilisation
Avoidance of bulky & expensive implant



Intramedullary Nailing

It provides less chance of unstable fixation than percutaneous screw/pinning. Polarus nail and polyaxial nail are availble in market with various type of jigs to provide easy fixation and polyethylene bushings to provide stable construct and less chance of backing out of screws. It injuries the rotator cuff while inserting. Absolute contraindication is fracture involving medial cortex and tuberosities.

Polarus Nail



Diphos Nail - polyaxial

Locking Compression Plate

Advantages are

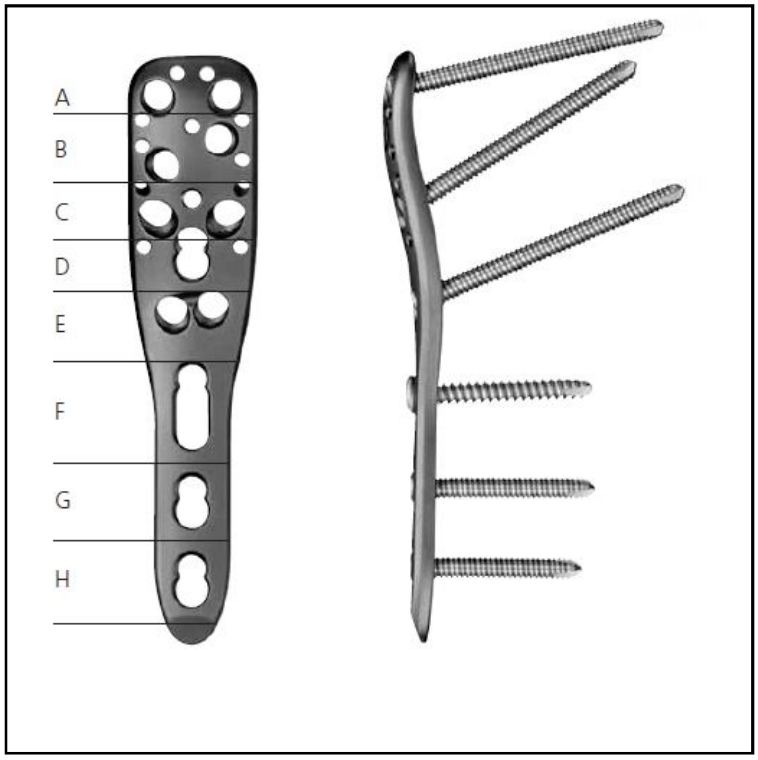
- Since it is a fixed-angle implant, it makes the fracture fragment to be more stable, particularly in more comminuted fracture patterns and in osteoporotic bone;
- early mobilisation makes rehabilitation to happen soon;
- less chance of soft tissue dissection especially rotator cuff;
- chance of implant removal is highly unlikely;
- reduced hardware complications &
- in patients with more complex fractures, the potential to avoid the use of hemiarthroplasty.

LCP Design

The 3.5 mm LCP Proximal Humerus Plate is part of the Small Fragment LCP System.

- Pre contoured plate proximal humerus
- Ten small holes for suture around the border of the proximal end
- Proximal locking holes accept 3.5 mm Locking Screws
- Locked & fixed angle construct in humeral head

- Head of the plate consists of 9 holes which are arranged in five rows as follows;
  - A & E - 4 holes aligned in centre at 95°
  - B - 2 holes that are convergent
  - D - 2 holes that are divergent
  - C - one hole in the centre aligned at 45°

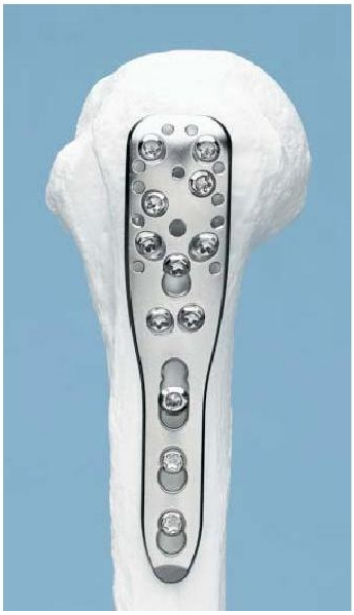


Arrangement of screws in PHILOS plate

- Distal shaft consists of three or five locking compression holes in the shaft, including one elongated hole to aid in plate positioning. These holes accept 3.5 mm Locking Screws in the threaded portion, and 3.5 mm Cortex Screws, 4.0 mm Cortex Screws, and 4.0 mm Cancellous Screws in the compression portion.

“Diverging” screw pattern

“Converging” screw pattern



Final Construct

MATERIALS & METHODS

This is a prospective study , conducted at Coimbatore Medical College & Hospital, Coimbatore in Department of Orthopaedics & Traumatology on those who were admitted with displaced fracture of Proximal Humerus from July 2014 to September 2015. Before including them in this study, informed consent was obtained from them in the language in which they were well versed , and ethical committee clearance was obtained for the same.

MATERIALS

Twenty two patients were admitted with displaced fracture of Proximal Humerus to Orthopaedic ward in the DEPARTMENT OF ORTHOPAEDICS AND TRAUMATOLOGY, COIMBATORE MEDICAL COLLEGE & HOSPITAL, COIMBATORE and involved in this study prospectively based on the following criteria.

Inclusion criteria:

1.Patients with displaced proximal humerus fracture, on basis of Neer's classification.

2. Open and closed fractures of proximal humerus.

3. Failure of conservative treatment.

4. Associated dislocation of shoulder.

5.Patients undergoing revision surgery for failure of other implants.

6.Patients who have given consent to this study.

Exclusion criteria

1. Metastatic & pathological fractures

2. Children (0-14 yrs)

3. Undisplaced fractures

4. Those who not will for surgery

Age, profession and sex of the patient, mode of injury, severity of the injury, associated injuries, time since injury and their function demands were noted down. Confirmed with radiographic evaluation including standard & special view. Intra-articular extent of fracture geometry were assessed with thin slice of CT scan in doubtful cases.

Fracture was classified using NEER'S Classification and planned pre-operatively according to it. Patient was treated with analgesics , U-slab till surgery. Co-morbidities were treated accordingly.

Intra-operative events, difficulties and complications, post operative radiological evaluations and bony union were noted. Patients were followed up at 2 weeks, 6 weeks, 3, 6 and 12 months with

radiographical evaluation and clinical examination and outcome. All patients at their final assessment, underwent radiological and functional evaluation using the CONSTANT score.

This study compises the sample of 22 patients, in which 6 were females and 16 were males. The age distribution was varied from 18years to 66 years with an average age of 42 years. Out of 22 patients, 10 patients were victim of road traffic accident in which one associated with fracture neck of femur on ipsilateral hip, 7 patients had self fall, 4 patients were fell from height (minimum 10 feet) and one was victim of an animal attack. Longest duration of follow up was 21 months with a mean follow up of 12 months. 3 patients lost follow up in this study.

In our study all were right handed persons and our study 14 patients had a fracture of the right proximal humerus and 8 patients had a fracture of the left proximal humerus. This because of right handedness and can be attributed to the left side driving in the roads and subsequent RTAs.

Table 1 : Sex Incidence

	Male	**Female**
Number	**16**	**6**
Percentage (%)	**73**	**27**

Chart 1: Sex Incidence

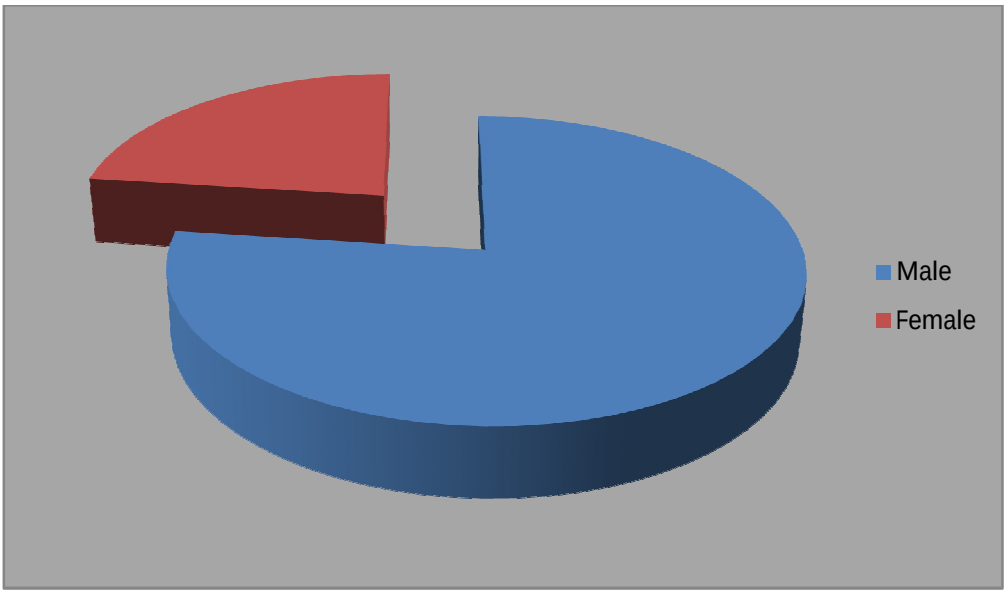


Chart 2: Age Distribution

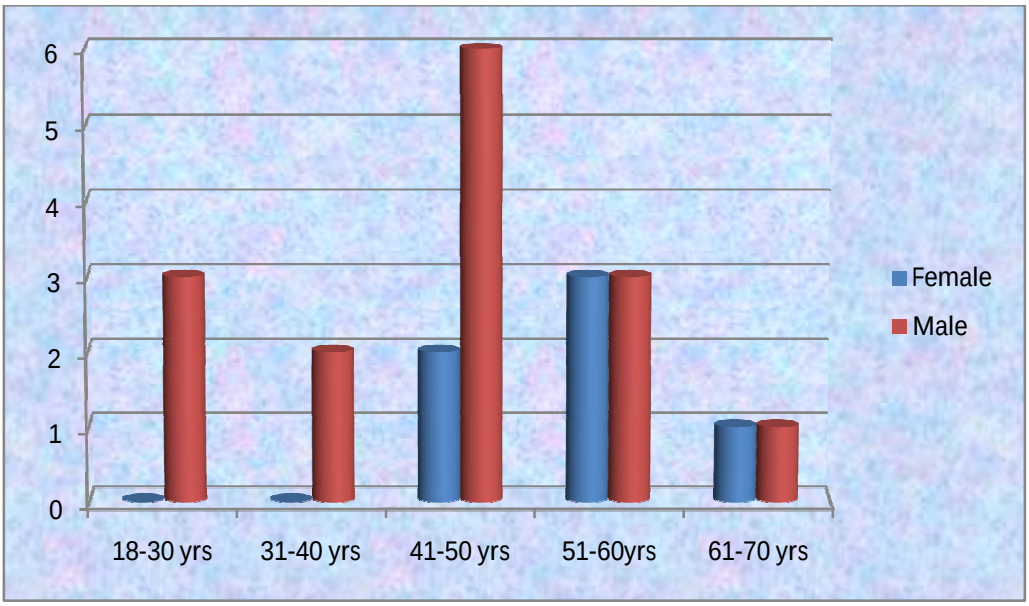


Table 2 : Age Distribution

	Male	Female
18-30 yrs	3	-
31-40 yrs	2	-
41-50 yrs	6	2
51-60 yrs	4	3
61-70 yrs	1	1
Total	16	6

Chart 3 : Side Involvement

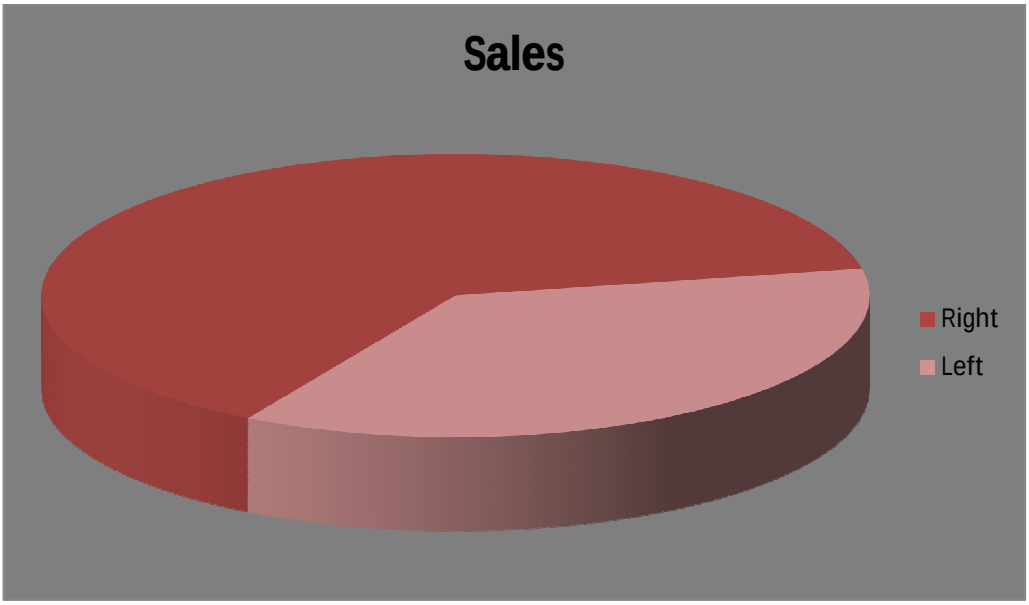
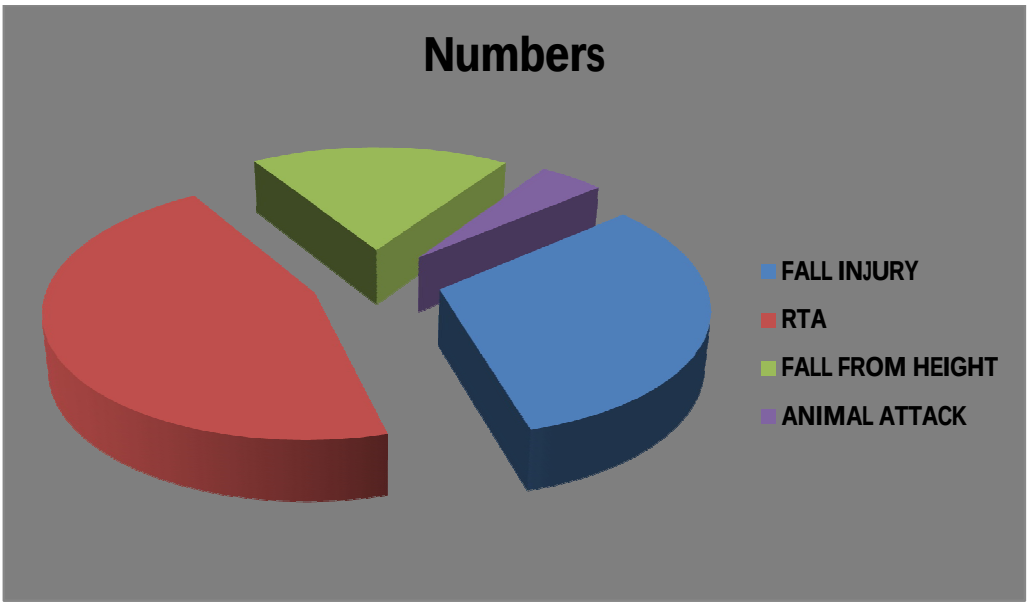


Chart 4: Mode of Injury



METHODS

After hemodynamic stabilization, detailed clinical history and clinical examination is undertaken from the patient who have been admitted in department of Orthopaedics & Traumatology, Coimbatore medical college & hospital.

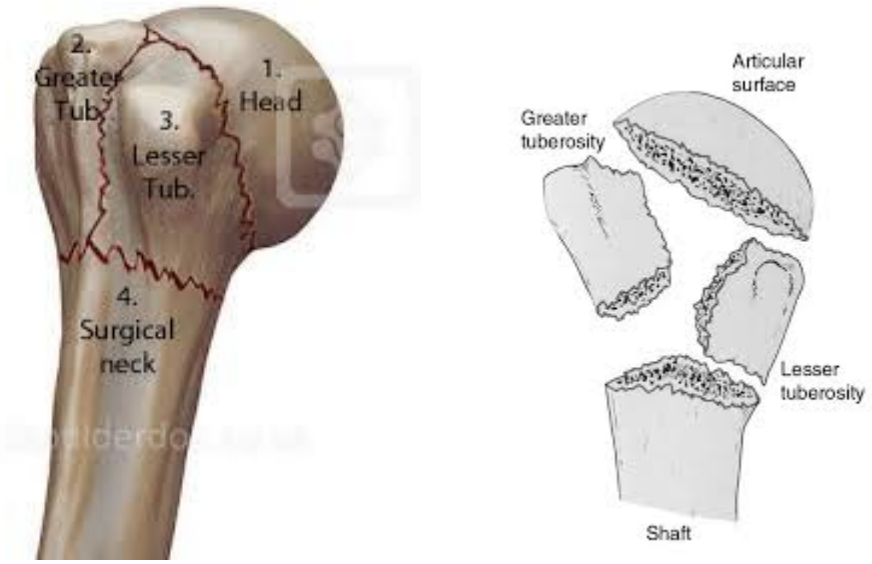
Patients were treated with appropriate analgesic & antibiotics(if necessary) . Then splinted with U-slab and cuff & collar was given. AP, lateral and axillary view radiographs were taken preoperatively. These were reviewed by to determine the Neer's classification of the fracture. In selected cases CT scan / special views were taken in order to know the extent of articular surface involved.

FRACTURE CLASSIFICATION [36, 37]

The Neer classification system is based on displacement criteria of 1 cm or fragment angulation of 45°. The type of fracture then is divided into segments. Four segments are possible, including the articular segment, the lesser tuberosity, the greater tuberosity, and the surgical neck.

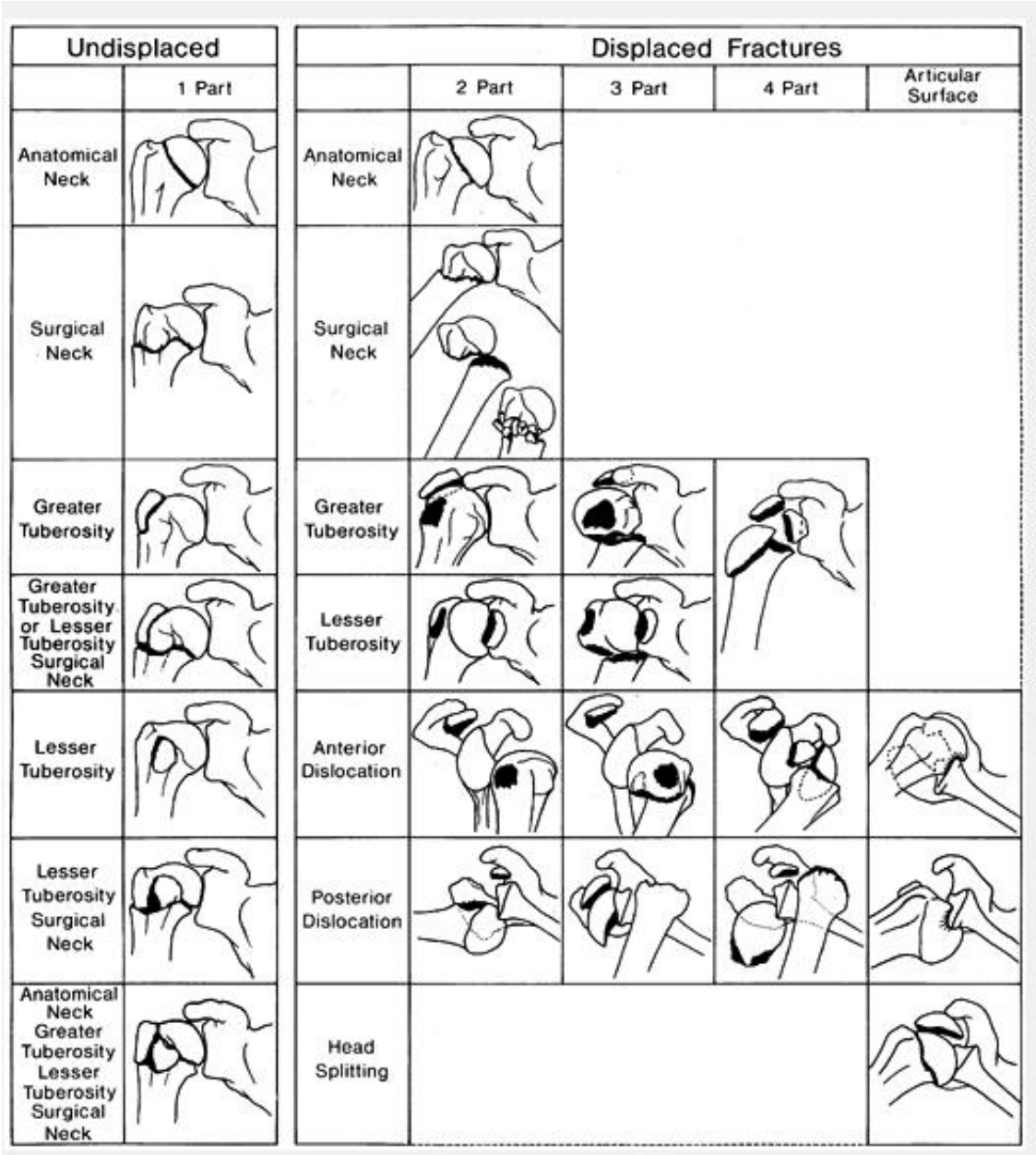
These four parts are separated by epiphyseal lines (bone growth plates) during the early developmental years. When the proximal humerus is broken, the fracture line predictably occurs along one or more of these planes.

More recently, displacement of greater tuberosity more than 5 mm is an indication of fixation.



Classification Based on Fracture Displacement

NEER CLASSIFICATION

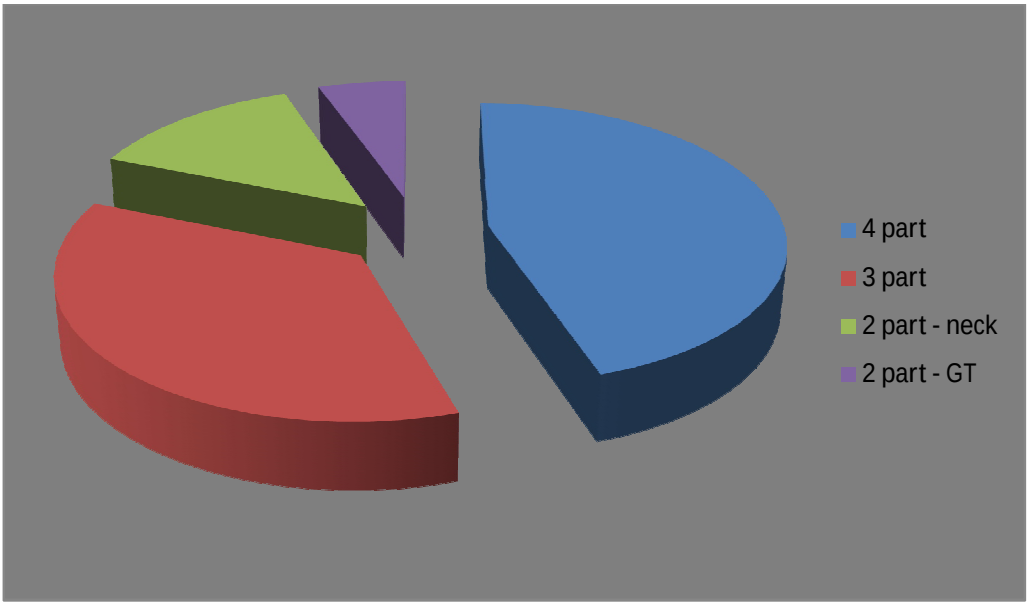


The fracture of all 22 patients were classified using NEER'S Classification. Out of 22 patients, 10 were had Neer's 4 part fracture (one - non union) , 8 were had Neer's 3 part fracture and 4 had Neer's 2 part fracture(3- surgical neck & 1 - greater tuberosity fracture).

Table 3 : Type of Fractures

Type of Fracture	Number of Patients
Two part - surgical neck	3
Two part - greater tuberosity	1
Three Part Fracture	8
Four Part Fracture	10

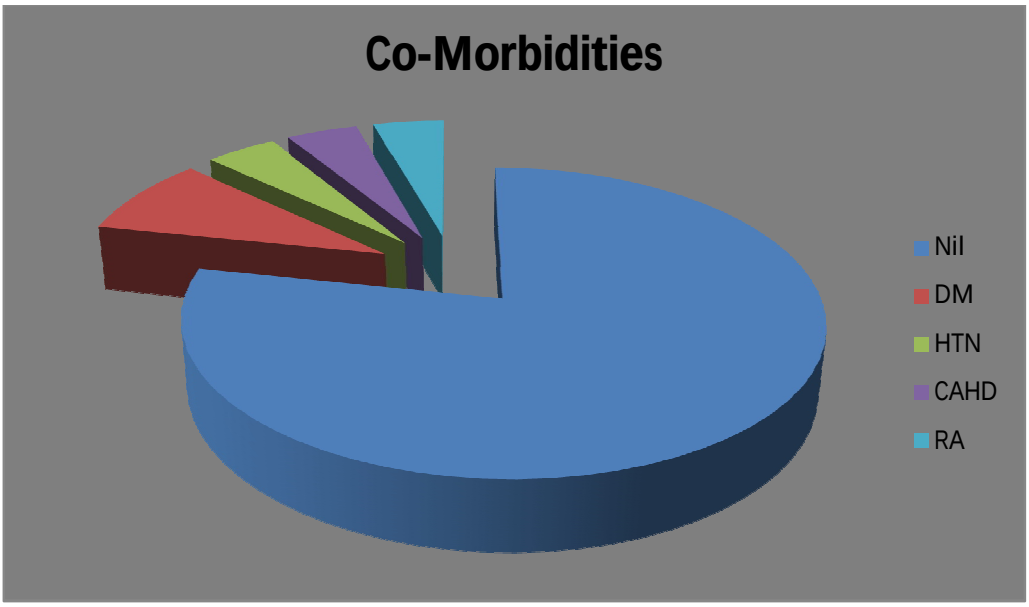
Chart 5: Type of Fracture - Neer's Classification



Co Morbidities

Out of 22 patients, 2 patients with diabetes, one is hypertensive, one is heart disease patient and one is suffering from Rheumatoid Arthritis.

Chart 6 : Co-Morbidities



All patients were treated operatively with proximal humerus locking plate. 15 patients were operated under c-arm guidance and rest without it. 17 patients were operated through deltopectoral approach and 5 were through deltoid splitting approach. The average duration of surgery is about 103 minutes ranging from 50 minutes to 155 minutes. The average blood loss is about 202 ml ranging from 50 ml to 300 ml. The average day of surgery from incident of injury is about 28 days ranging from 2 days to 51 days. No intra operative anaesthetic

complications. No neurological deficit due to anaesthetic complications and surgical complications.

SURGICAL TECHNIQUE FOR PLATE OSTEOSYNTHESIS – DELTOPECTORAL APPROACH [38]

With the patient in supine position in fracture table with 30 - 45° angulation at head end,with a sandbag behind the operating scapula , a deltopectoral/ deltoid splitting approach were used.

Locate the deltopectoral groove percutaneously. In an obese patient, the groove is located by abduction and external rotation of the shoulder with pressure behimd the scapula. Start the incision at coracoid proces, and extend it distally along the deltopectoral groove to the deltoid insertion for approximately 15 cm

Develop skin flaps to expose the deep fascia. Open the fascia over the deltopectoral groove with blunt scissors, looking for the cephalic vein. This vein serves as an important landmark for identifying the avascular interval between the deltoid and pectoralis major muscles. Bluntly develop this interval, and retract the deltoid laterally and the pectoralis major medially. The vein can be ligated or retracted with the deltoid laterally.

The anterior circumflex artery lies in the middle of the wound, just superior to the pectoralis major muscle; they may need to be isolated, clamped, and coagulated.

Wider exposure is possible if the muscle origins from the coracoid are transected. If more proximal exposure is needed, it may be necessary to transect the origin of the pectoralis minor muscle. In such cases, release the origins of the coracobrachialis and the short head of the biceps from the tip of the coracoid, leaving a cuff on the tip of the coracoid for repair.

It is better to avoid devascularization of the fracture fragment by meticulous dissection of tendino osseous attachments. The osseous attachments of the rotator cuff are pull together to reduce the fracture.

If reduction is difficult, insert a k-wire as a joystick in the humeral head to rotate the head into a reduced position. or place sutures under the rotator cuff tendon (supraspinatus) also can be helpful for mobilization & reduction.

For 3-part or 4-part fractures or osteoporotic fragments, place sutures into the rotator cuff tendons attached to fractured fragments to aid in reduction.

Place the plate onto the greater tuberosity, just posterior to the biceps tendon, and temporarily fix it with Kirschner wires; confirm correct plate position in c-arm both in ap view in adduction and abduction. If plate placement is too proximally , it may cause impingement and If plate placement too close to the biceps tendon may damage the anterior humeral circumflex artery.

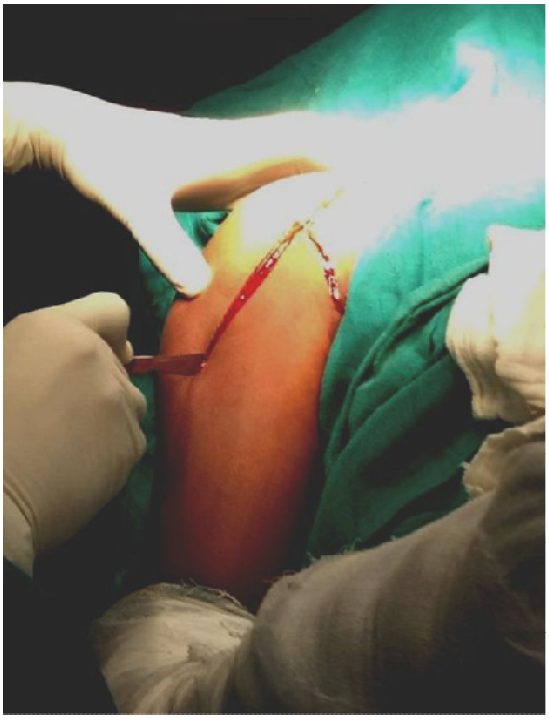
If plating is preferred, plate is placed at least 8 mm distal to the tip of the greater tubercle and fixed to the humeral shaft with screws.

If there is fractures with medial comminution, first fix the plate to the head with screws, and reduce the shaft segment to the plate. This helps avoid varus malposition, which is associated with higher failure rates. Screw insertion into the inferomedial humeral head adds stability for fractures without medial calcar support.

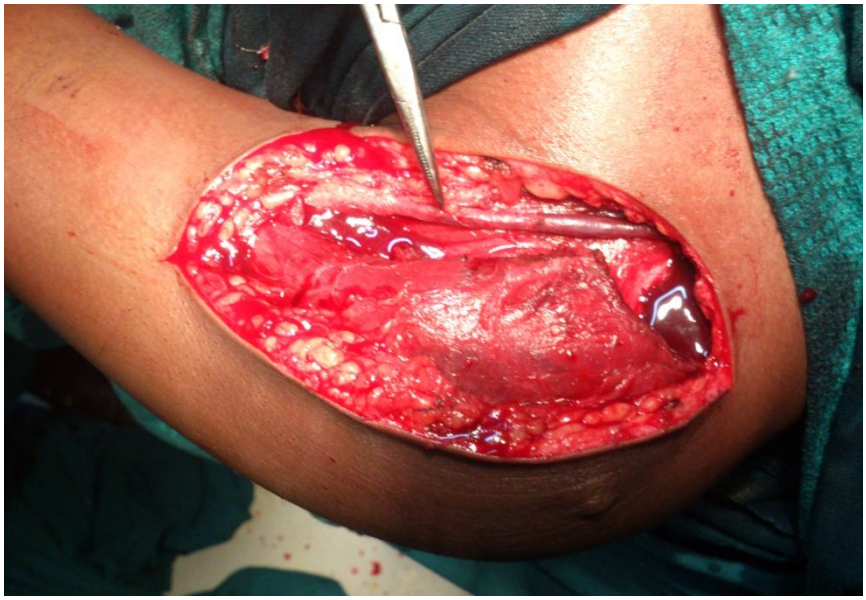
Confirmation with c-arm on anteroposterior and lateral views is necessary for reduction and screw placement .

INTRA OPERATIVE IMAGES

Position of patient with bump under ipsilateral shoulder & drapped

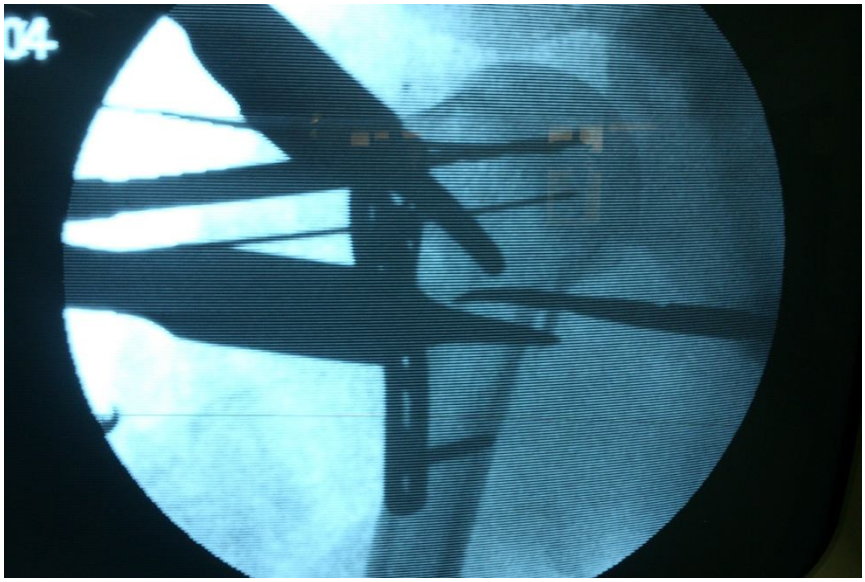


Skin incision for Deltopectoral Approach



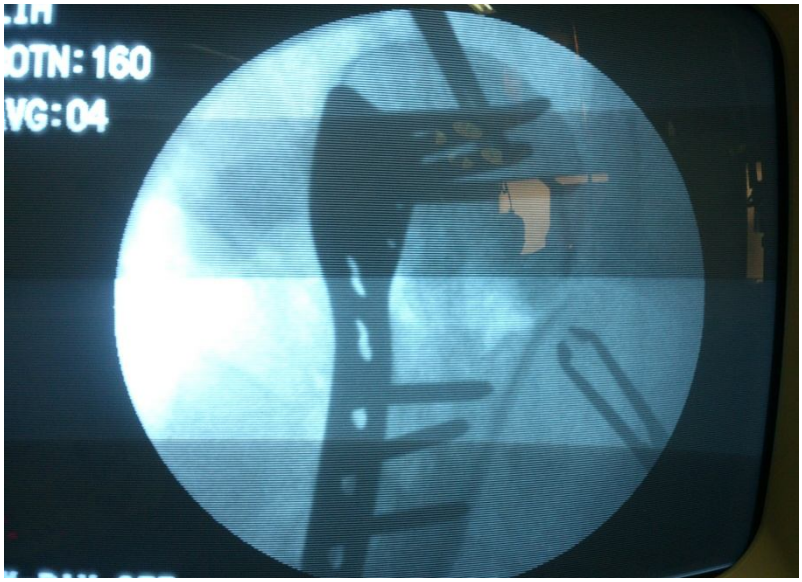
Cephalic vein in deltopectoral groove

Fracture of proximal humerus seen through Deltopectoral groove



Fracture reduced and provisionally fixed with k wires, reduced and fixed to distal fragment with locking screw.

Fixed with screws proximally and distally



Final construct with philos plate for proximal humerus fracture

Wound closed in layers over suction drain

POST OPERATIVE PROTOCOL[39,40]

Postoperatively, the arm was immobilized in a sling. The drain was removed on 2nd post operative day. The time for commencement of shoulder rehabilitation was determined by stability of fixation , quality of bone, and compliance of patient. Passive ROM exercises (ie, pendulums, passive forward elevation, external rotation) generally were begun on the first postoperative day provided that a stable reduction was achieved. Active ROM of the elbow, wrist, and hand was also begun immediately after surgery. The patient then progressed through a three-phase rehabilitation program, consisting of passive assisted exercises early, active exercises starting at approximately 6 weeks postoperatively, and strengthening or resisted exercises beginning 10 to 12 weeks after surgery. Early passive assisted exercises help to avoid adhesion formation. No limitation of exercises within the pain-free ROM was necessary during this time provided that bone stock was good and medial buttressing adequate. Shoulder strengthening and resistance exercises were initiated only after bony consolidation was confirmed on plain radiographs and adequate coordination of the extremity had been achieved.

Standard AP, axillary, and scapular Y radiographic views were taken immediately after surgery. Routine follow-up radiographs were taken 2, 6 weeks, 3,6 & 12 months postoperatively to ensure that no pin has migrated, no loss of reduction has occurred, evidence of callus formation and consolidation of fracture . Plate removal was generally not necessary.

CASE ILLUSTRATIONS

Case – 1

53 years old female

Fall by herself

Neer 3 parts fracture Right side

Open Reduction and internal fixation with Locking plate.

Duration of surgery – 90 minutes

Radiological fracture union: 12 weeks

Range of Motion:

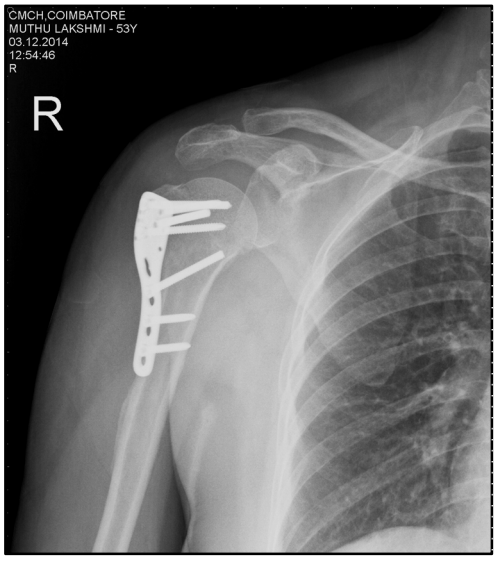
Flexion - 160
Abduction - 160
External Rotation- 70
Internal Rotational- 70

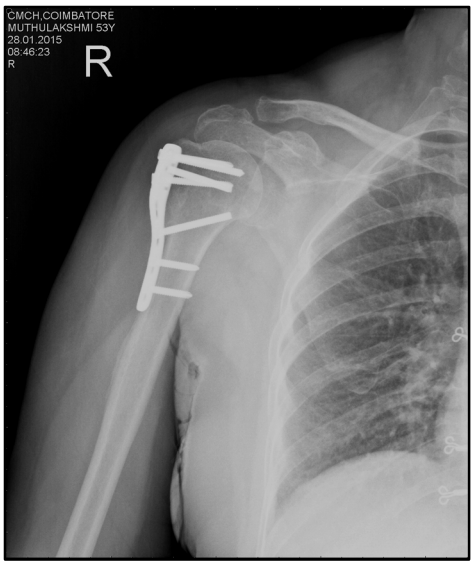
Constant score – 79

Comment – Good

Case 1- Radiographs

Pre-operative picture





Immediate post op **3 month follow up**

Functional Outcome

Case – 2

24 years old male

Fall from 20 feet height

Neer 4 parts grade IIIb open fracture Right side

Wound debridement & Open Reduction and internal fixation with Locking plate.

Duration of surgery – 150 minutes

Radiological fracture union: 12 weeks

Range of Motion:

Flexion - 90
Abduction - 90
External Rotation- 70
Internal Rotational- 50

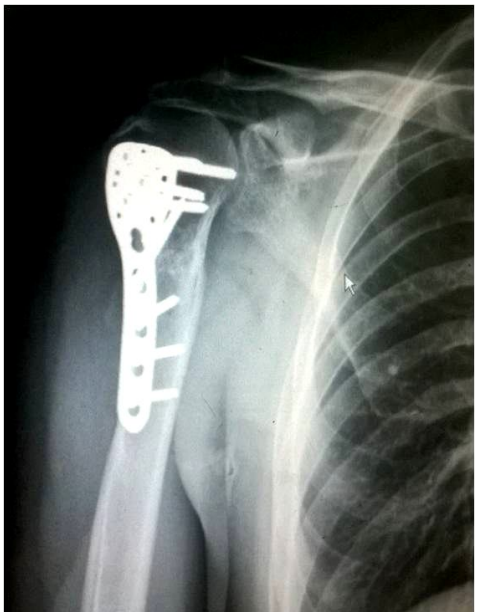
Constant score – 75

Comment – Good

Case 2 - Radiographs

Pre op radiograph

Immediate post op radiograph



One & half year follow up with chronic osteomyelitis

After Implant exit

Case 2 Functional Outcome

Case 3

18 years old male

Fall from 20 feet height

Neer 2 parts surgical neck fracture Right side

Open Reduction and internal fixation with Locking plate.

Duration of surgery – 90 minutes

Radiological fracture union: 6 weeks

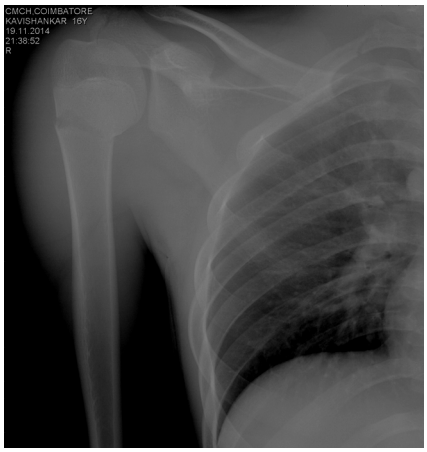
Range of Motion:

Flexion - 160
Abduction - 180
External Rotation- 70
Internal Rotational- 90

Constant score – 92

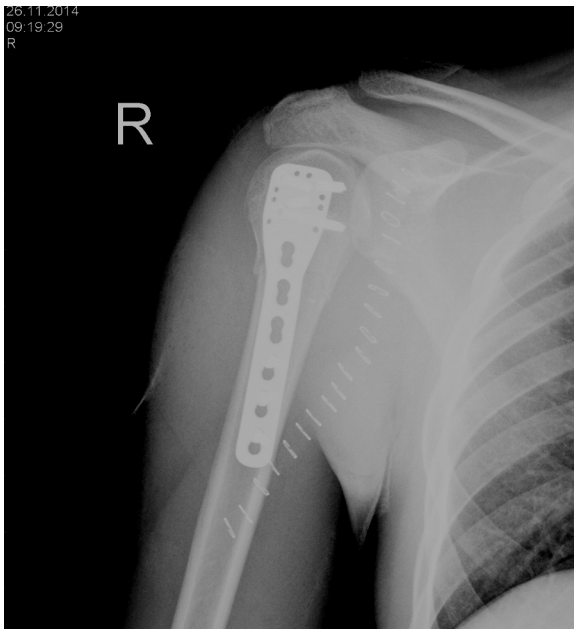
Comment – Excellent

Case 3 - Radiographs



Pre op radiograph

CT Scan - 3 D shows angulation more than 30°



2 weeks follow up

Case 3 - Functional Outcome

Case 4

65 years old female

Fall on out stretched hand

Neer 3 parts fracture Left side

Open Reduction and internal fixation with Locking plate.

Duration of surgery – 90 minutes

Radiological fracture union: 12 weeks

Range of Motion:

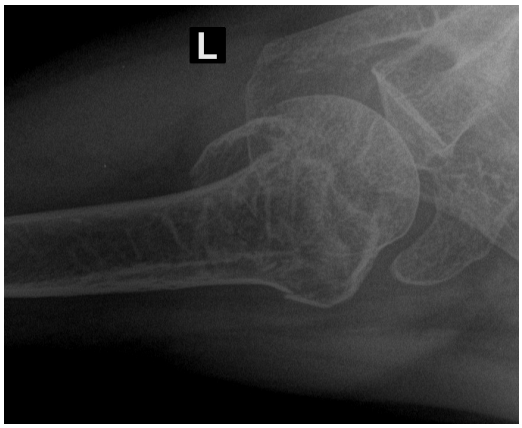
Flexion - 120
Abduction - 90
External Rotation- 40
Internal Rotational- 50

Constant score – 60

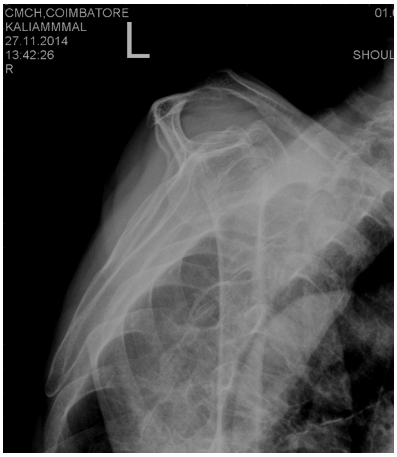
Comment – Moderate

Case 4 - Radiographs

Anteroposterior view

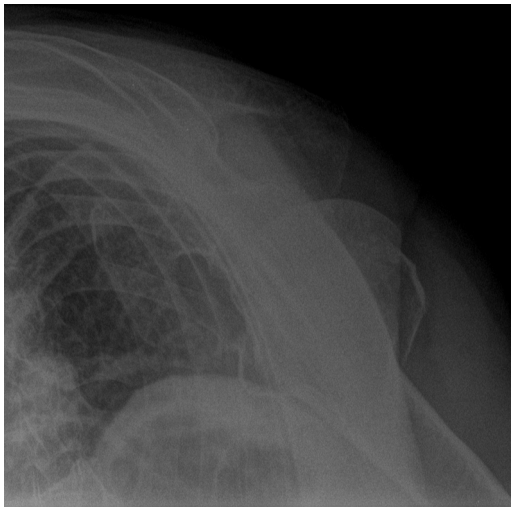


Axillary View



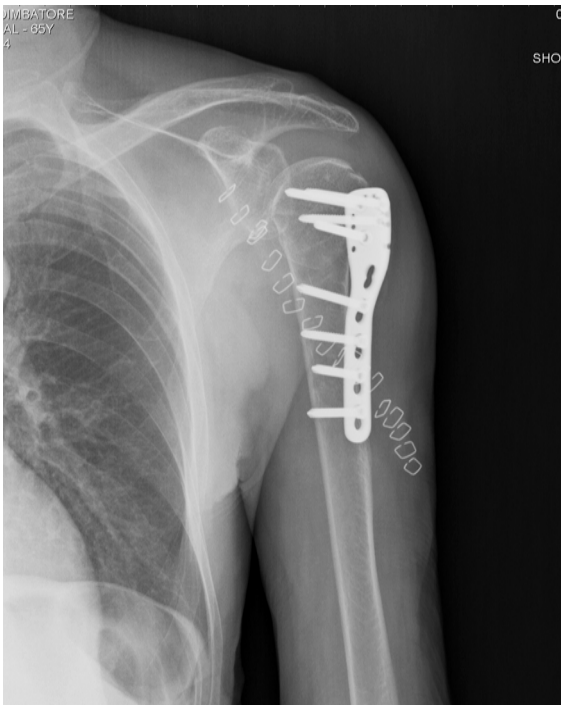
Scapula Y View

West Point View

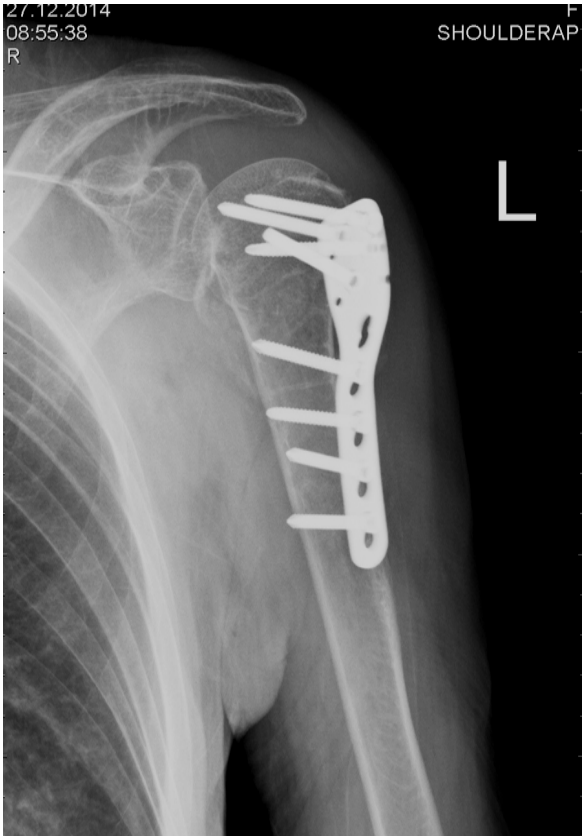


Velpeau View

Case 4 -Radiographs



Immediate Post op xray



12 weeks follow up

Case 4 - Functional outcome

Case 5

44 years old male

Road Traffic Accident

Neer 4 parts fracture Right side

Open Reduction and internal fixation with Locking plate.

Duration of surgery – 90 minutes

Radiological fracture union: 6 weeks

Range of Motion:

Flexion - 170
Abduction - 120
External Rotation- 80
Internal Rotational- 70

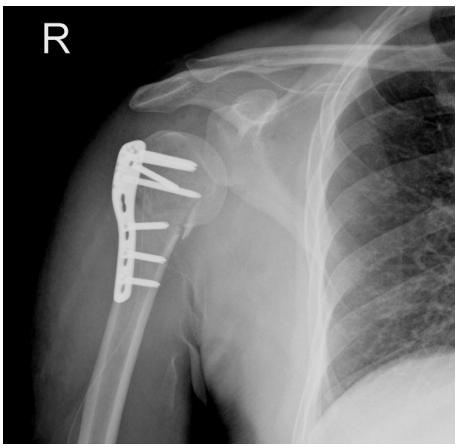
Constant score – 91

Comment – Excellent

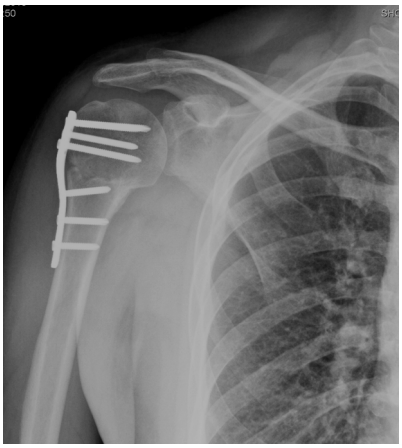
Case 5 - Radiographs

Pre op Xray - 4 part fracture

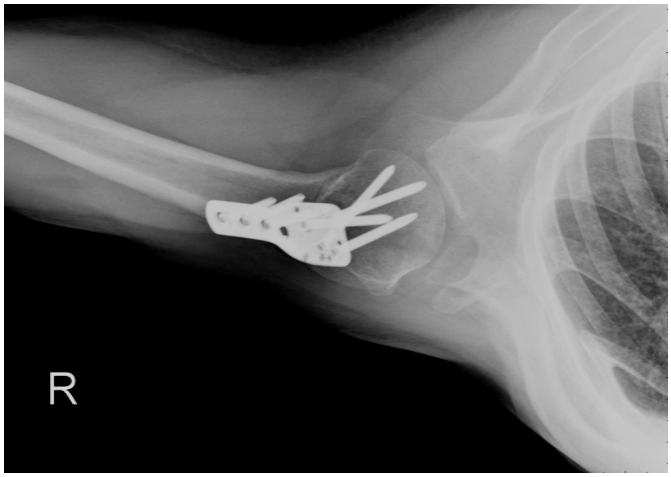
CT shoulder shows 4 part Fracture



Immediate post op

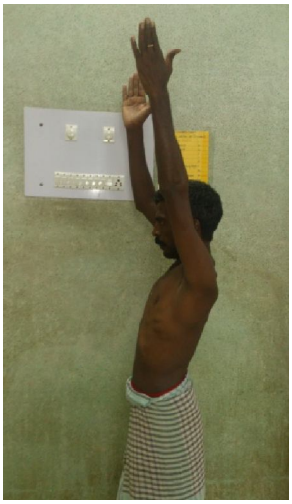


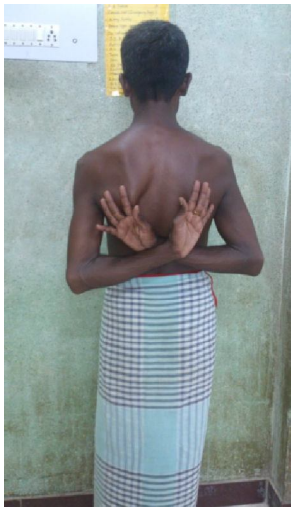
12 weeks follow up - fracture consolidated



12 weeks follow up - Axillary view

case 5 Functional outcome





EVALUATION

A physical examination was performed, the Constant score was calculated, and radiographs of the proximal part of the humerus were made and evaluated for bony healing, signs of malunion, nonunion or avascular necrosis.

The Constant score assigns points for Pain, Range of movements, Power and Activities of daily living. Muscle strength was measured with use of a 1 kg weight in the patient's hand and the shoulder in 90° of abduction, or, if 90° could not be reached, in maximum active abduction as described by Constant.[41]

The Constant score was graded as

Poor	(0 to 55 points),
Moderate	(56 to 70 points),
Good	(71 to 85 points),
Excellent	(86 to 100 points).

CONSTANT SCORE

Patient's Details

Operation/Diagnosis: **Date:** _____

Side: R L

Examination: Pre-op
3 months 6months
1 year 2 years ___ years

A.- Pain (/15): Average (1 + 2) ☐ A

1. Do you have pain in your shoulder (normal activities)?
   No = 15 pts, Mild pain = 10 pts, Moderate = 5 pts, Severe or permanent = 0. ___

2. Linear scale:
   If "0" means no pain and "15" is the maximum pain you can experience, please circle where is the level of pain of your shoulder. (Points given are inverse to the scale. E.g. level 5 in the scale means 10 points)

Level of pain:

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Points: ___

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

B.- Activities of daily living (/20) Total (1 + 2 + 3 + 4) ☐ B

1. Is your occupation or daily living limited by your shoulder?
   No = 4, Moderate limitation = 2, Severe limitation = 0 ___
2. Are your leisure and recreational activities limited by your shoulder?
   No = 4, Moderate limitation = 2, Severe limitation = 0 ___
3. Is your night sleep disturbed by your shoulder?
   No = 2, Sometimes = 1, Yes = 0 ___
4. State to what level you can use your arm for painless, reasonably activities.
   Waist = 2, Xiphoid (sternum) = 4, Neck = 6, Head = 8, Above head = 10 ___

C.- Range of movement (leave this for the doctor or physiotherapist) (/40): Total (1 + 2 + 3 + 4) ☐ C

1.- FWD Flexion: ___

0 - 30	0 pts
31 - 60	2 pts
61 - 90	4 pts
91 - 120	6 pts
121 - 150	8 pts
> 150	10 pts

2.- Abduction: ___

0 - 30	
31 - 60	
61 - 90	
91 - 120	
121 - 150	
> 150	

3.- External Rotation: ___

Hand behind head & elbow forward	2
Hand behind head & elbow back	4
Hand above head & elbow forward	6
Hand above head & elbow back	8
Full elevation of arm	10

4.- Internal Rotation: (Dorsum hand to) ___

Thigh	0
Buttock	2
SI joint	4
Waist	6
T12	8
Between shoulder blades	10

D.- Power (/25): Points: average (kg) x 2 = ☐ D

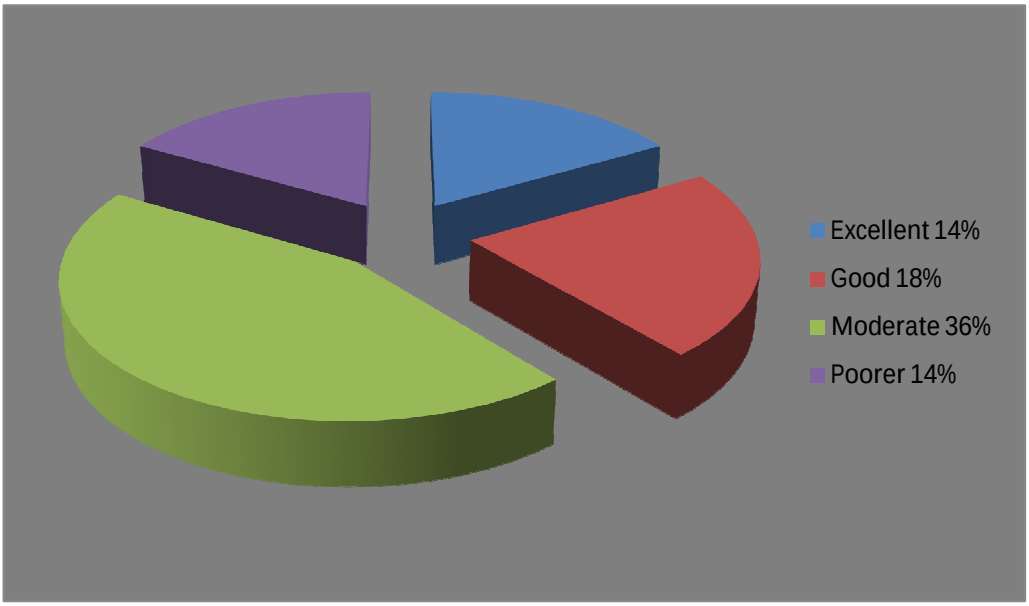
First pull: Second pull: Third pull: Fourth pull: Fifth pull:
Average pulls:

TOTAL (/100): A + B + C + D ☐

Table 4 : Evaluation

Result - Outcome	Numbers	Percentage (%)
Excellent	**3**	**14**
Good	**4**	**18**
Moderate	**8**	**36**
Poorer	**3**	**14**
Lost follow up	**4**	**18**

Chart 7 : Evaluation



RESULT

Out of the 22 patients followed up, 3 patients had excellent scores, 4 had good scores , 8 had moderate scores and 3 had poor outcome scores. Mean constant score is 67.28 (range 38-92 points). Mean constant score for Neer two part fracture was 75 (range 56 – 92), for Neer's three parts fracture was 66.71(range 38 – 91) and for Neer's four parts fracture was 60.14 (range 40 – 81). Mean constant score for middle age group(18-40) was 79.5 (range 75 – 92), for old age group(41-60) was 62.91(range 38 – 91) and for very old age group(>60) was 60.0 (one case - 60).

Table 5 : Consant Score vs Neer's parts of Fracture

Neer's Classification	Constant Score	Number
Two Part	75 (range 56 – 92)	4
Three Part	66.71(range 38 – 91)	8
Four Part	60.14 (range 40 – 81)	10

Chart 8: Mean Constant Score as per Neers Classification

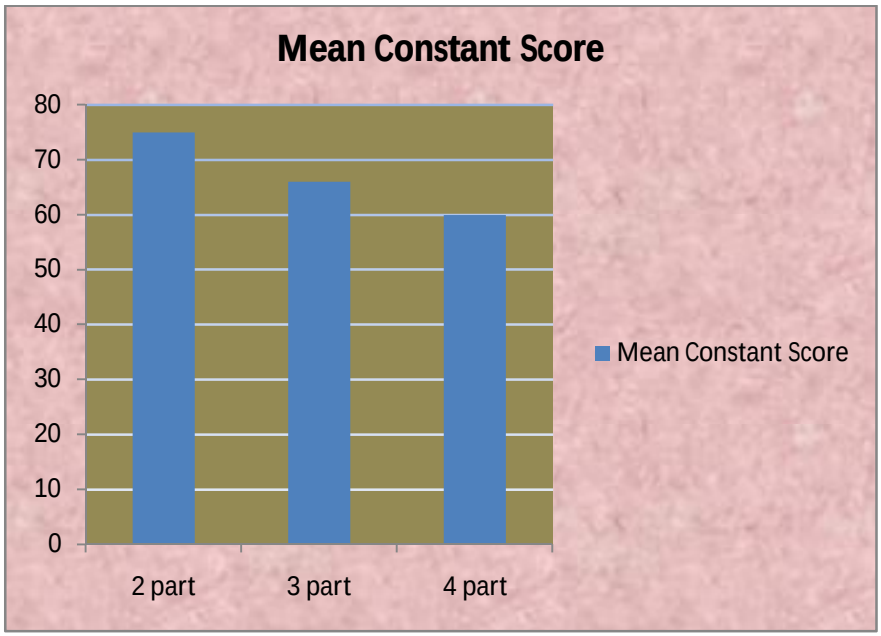


Chart 9 : Mean Constant Score as per Neers Classification

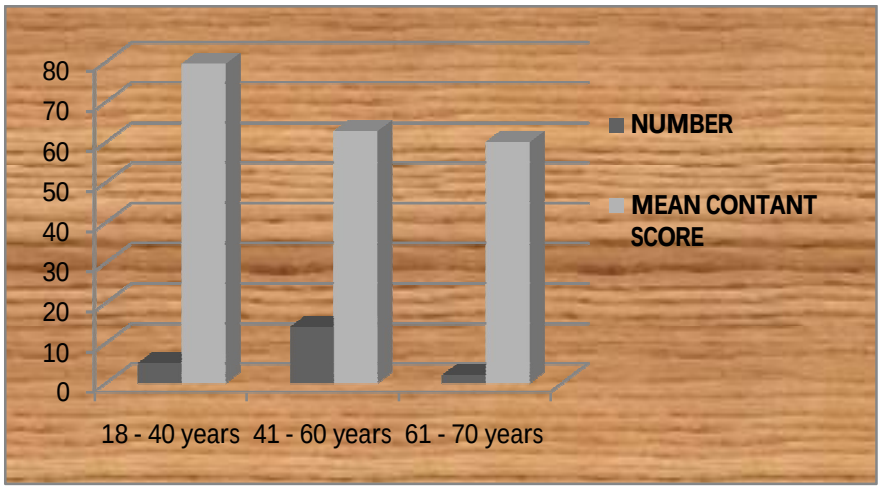


Table 6 : Mean Constant Score Vs Age Distribution

Age Distribution	Mean Constant Score	Number
18 - 40 yrs	**79.5**	**4**
41 - 60 yrs	**62.91**	**14**
> 60 yrs	**60**	**2**

Eighteen patients out of twenty two patients have gone for union at around 9 weeks follow up (88%) , except those complicated by screw pull out, osteonecrosis and fixation failure.

COMPLICATION

The common complications after fixation of fractures of proximal humerus are restricted movements, restrictive pain, wound infection, failure of fixation, avascular necrosis of humeral head and late rupture of the rotator cuff.[42,43]

Two patients, one with Neer 2 part fracture later leads to osteonecrosis of the humeral head. One who with 4 part fracture encountered backing out of screw with failure of fixation and finally leads to Osteonecrosis who undergone implant exit and planned for hemiarthroplasty of shoulder. Unfortunately Patient not willing for further procedure.

Avascular necrosis is not in itself a clinical problem. However, it may end up in partial or total collapse of the humeral head with incongruency. This may result in malfunction and pain, although the x-ray appearance frequently does not correlate with the clinical picture.

One patient with Neer 4 part fracture treated with locking compression plate had failure of fixation with collapse of fractured fragments on second post operative month and patient was on lost follow up.

Postoperative wound or bone infection is one of the common complication. It can be classified as acute (<21 days), intermediate

(between 21 and 56 days) or chronic (>56 days). Once the purpose of implant is over, it can be removed.

One patient with Neer 4 parts open fracture leads to chronic osteomyelitis for which iv antibiotic followed by oral antibiotic according to culture & sensitivity, waited till bone union and finally undergone for implant exit.

Table 7: Complication of Philos Plate

COMPLICATIONS	NO OF PATIENTS
Perforation of screw	1
Chronic Osteomyelitis	1
Failure of Fixation	1
Osteonecrosis	2
Malunion/Non union	0

DISCUSSION

The treatment of complex humeral 3- or 4-part fractures represents a challenge. The surgeon must obtain an exact anatomical reduction and stable fixation, and at the same time minimise the iatrogenic risk of screw penetration and avascular necrosis of humeral head by maximal protection of the periarticular soft tissues.

Poor results in these complex fractures are due to following causes:

1) Inadequate fracture reduction especially medial cortex
2) Unstable fixation
3) Incorrect positioning of the fixation devices .

There is consensus in the literature that, regardless of the procedure and the implant chosen, a good functional final result depends mainly on anatomical reduction of the fracture combined with a stable fixation, and early initiation of functional rehabilitation of the shoulder. But in this study, age of the patient, minimal part of fractures and early fixation of fracture , directly increase the functional outcome.

In recent decade, rigid internal fixation of fracture have been increasingly used in the operative care of proximal humeral fractures.

Inspite of an early and secure functional postoperative therapy, it was believed that these implant would reduce the risk of secondary reduction loss in osteoporotic patients.

In the very old age group with osteoporosis, functional outcome after conventional plate osteosynthesis was poor.[44] In order to obtain better and reproducible results, the AO/ASIF has developed a special locking compression plate (Philos) for fractures of the proximal humerus.[45] Patients with good bone quality have previously been treated successfully with the conventional plate osteosynthesis.[46]

In this study, most of the patients (i.e;14 out of 22) lie in the group of 41- 60 years , a group highly prone for osteoporosis.

In normal conventional plates, the chance of backing out or cutting out of screws is more. It is difficult to hold the bony fragments as they are highly fragile due to osteoporosis, thereby affecting proper reduction. The normal screws are highly prone for soft tissue dissection, and all these accounts for the high rate of failure in procedures using conventional plates in an osteoporotic bone.

With advent of locking plates, the fraction of backing out or cutting out of screws are reduced due to the locking head and fixed angle present in fixed angle screws.

Due to multidirectional nature of screws in the locking plate, which spans through sphericity of head and not the centre alone, reduces the failure in fixation and collapse of head of humerus.

Suturing of tendons with eyelets of plate is possible in locking plates which reduces the risk in fixation of small fragments of osteoporotic bone which was otherwise hard, and also reduces the possibility of collapse.

Soft tissue dissection rates are similar in both conventional and interlocking plates, but with the skills of surgeon and meticulous surgical procedures this negativity can be overcome.

In bone plate interface, the reduced compression effect of locking plates when compared to conventional plates, play a high role in reducing avascularityof the bony fragments and head of humerus.

The average clinical result obtained in our study, with a mean Constant-Murley score of 67.28 points is satisfactory.

Comparable studies of internal fixation of Proximal humerus fractures demonstrate similar short term results. Although the follow-up period of our series was short, studies have shown that early function is comparable to final long term outcome. The outcome seems to correlate with fracture severity, anatomic reduction, etiology, bone quality, length of time elapsed from injury to surgery, concomitant injuries and the exact positioning and fixation of the implant.[47]

Table 8: Functional scores achieved with different treatment options for proximal humeral fractures in the current literature.[48 to 54)

Study	Type of fixation	Constant score	Neer's classification
Kuchle et al (2006)	Cloverlaef plate	72.4	2,3& 4 part fracture
Ketter et al (2006)	Angle stable humerus plate	70.0	2,3&4 part fracture
Lill et al (2003)	Angle stable humerus plate	72.5	2,3&4 part fracture
Kollig et al (2003)	T palte, screws & k wires	72.1	3 & 4 part fracture
Wijgman et al (2002)	Classic T Plate cerclage	80.0	3 & 4 part fracture
Gerber et al	Internal fixation	78	2,3,& 4 part fracture
Hessman et al	T plate	69	2,3,& 4 part fracture
Our study	Locking plate	67.28	2,3,& 4 part fracture

A meticulous anatomical reduction with appropriate plate positioning led to a significantly better result. The Constant-Murley score was significantly lower if anatomical reconstruction did not succeed or a nonanatomical reconstruction was accepted intraoperatively, and/or when the plate was not correctly positioned on the shaft at the proper height to avoid subacromial impingement.

In our study, three cases (14%) with poor outcome scores include one case of osteonecrosis of humeral head, one case of improper reduction , one case of shoulder stiffness due to delay in surgery. There is no significant poorer result in perforation of screws in joint and in chronic infection

The 4.5 % (1 / 22 patients) infection rate in our series is comparable to the 2.5% (2 / 41 patients) patientsof Paavolainen et al (1983).

The development of aseptic humerus head necrosis (2 patients or 9%) significantly affected the clinical result ; these patients only achieved a mean Constant-Murley score of 45.0. In the literature the rate of necrosis for 3-and 4-part fractures has been between 0% and 50%, depending on the osteosynthesis procedure. The rate of aeptic necrosis (9%) in our study is acceptable and is as same as other literature.

Table 9 : Aseptic Necrosis rate in various studies

Study	Type of Fracture	Method of Fixation	Incidence
Hessmann et al	2,3& 4 parts	T plate	4%
Fankhauser et al	AO - A,B,C	Locking plate	10%
Gerber et al	2,3 & 4 parts	Locking plate	12%
Our study	2,3 & 4 parts	Locking plate	9%

Early fixation, exact anatomical repositioning of the fracture fragments and rigid internal fixation was associated with a significantly better functional result. The results attained in our patients gains less importance of the restoration of the correct anatomical relationship between the individual fragments.

The functional results after rigid fixation of three- and four-part fractures using a locking plate were shown to be better than conservative treatment or semi-rigid fixation without anatomical reduction of the head fragment. Shoulder function continued to improve as the strength and function of the muscles increased.

CONCLUSION

Although our study was relatively short and it was not a randomized controlled study, the results are comparable with other published journals.

Accurate anatomical reduction gains and early fracture fixation are more important than the implant used, to get a good final functional outcome, and this factor is independent from the implant design and procedure selected.

The options as to the surgical approach or the type of implant used depend on the pattern of the fracture, the quality of the bone encountered, the patient's goals and the surgeon's familiarity with the techniques. The learning curve with the implants chosen certainly also plays a role. An adequate surgical technique will minimise complications and an aggressive rehabilitation regime will ensure the best possible result.

There is no much difference among 2,3 & 4 parts of fracture with locking plate. All are nearly more or less with good function outcome.

In general, 2- and 3-part fractures can be treated with open reduction and internal fixation (a plate with screws is the choice). Four-part fractures in the younger, active patient also can be treated successfully with open reduction and internal fixation.

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PRO FORMA
Patient's Details

Patient Name **Sex: M/F/TG**	**Age:**
Occupation :	**IP NO:**
Address:	**Contact:**
Unit:	**Professor: Dr S Elangovan M.S.,D.Ortho.,**
DOA :	**DOS :** **DOD:**
Clinical History : **Presenting Complaints :** **Mode Of Injury :**	

Clinical Evaluation

Pre Injury Status	
Ambulation :	**CVS :**
Obesity :	**RS :**
Diabetes :	**CNS :**
Hypertension :	**Psychiatric Illness :**
Previous Hip Surgery :	

Background Data

Smoker :

Alcohol :

Drug Intake :

Associated Injuries

Head Injury :

Chest Injury :

Other Fractures :

If any

Local Examination

Shoulder Region :

Open /closed injury:

Skin condition :

Deformity :

Radiological Evaluation

x-ray shoulder (affected side)

AP view :

Axillary view :

x-ray chest AP view :

CLASSIFICATION :

Fracture pattern : Neer's I /II/III/IV (parts) of proximal Humerus

Diagnosis :

Plan :

OPERATIVE DETAILS

Day of Surgery from Injury :

Anaesthesis : GA/RA/TIVA **Under ASA : I/II/III/IV**

Operative technique

Approach : **Position :**

Type of Plate :

Duration of surgery : **Amount of blood loss:**

Per operative findings :

Post-operative :

Units of blood transfused :

Duration of I.V. Antibiotics :

Thrombo-prophylaxis :

Post operative Evaluation

Fever : **Pain :**

Wound discharge : **Swab for C & S in case of infection :**

Neurovascular injury :

Rotational deformity :

Radiological Evaluation :

At the time of discharge

Shoulder CONSTANT Score : / 100 points

Wound healing :

Duration of hospital stay :

Complication :

FOLLOW UP

2ND WEEK Date :

Wound healing :

Radiological evaluation :

Constant score :

Advice & Remarks :

Professor

6th WEEK Date :

Clinical Status :

Radiological evaluation :

Constant score :

Advice & Remarks :

Professor

3rd WEEK **Date :**

Clinical Status :

Radiological evaluation :

Constant score :

Advice & Remarks :

Professor

6th MONTH **Date :**

Clinical Status :

Radiological evaluation :

Constant score :

Advice & Remarks :

Professor

ONE YEAR **Date :**

Clinical Status :

Radiological evaluation :

Constant score :

Advice & Remarks :

Professor

CONSENT FORM

You, Shri./ Smt./ Kum. _____, aged ____ years, S/o / D/o / W/o _____, residing at _____ _____ are requested to be a participant in the research study titled '*A prospective observational study - functional outcome of proximal humerus plating in displaced proximal humerus fractures* ' in Government Medical College Hospital, Coimbatore, conducted by Dr.R Ragavanandam, Post Graduate Student in the Department of Orthopaedics, Coimbatore Medical College. You satisfy eligibility criteria as per the inclusion criteria. You can ask any question or seek any clarifications on the study that you may have before agreeing to participate.

RESEARCH BEING DONE

A prospective observational study - functional outcome of proximal humerus plating in displaced proximal humerus fractures

PURPOSE OF RESEARCH

1. To evaluate the treatment outcome of PHILOS plating for displaced proximal humerus fractures.

2. To improve stability in osteoporotic humeral bones.

3. To preserve the biological integrity of the humeral head and to secure an anatomical reduction with multiple locking screws with angular stability .

PROCEDURES INVOLVED

The research includes operative treatment for proximal humerus fractures and viewed in radiograph to assess the fracture reduction.

DECLINE FROM PARTICIPATION

You are hereby made aware that participation in this study is purely voluntary and honorary and that you have the option and the right to decline from participation in the study.

PRIVACY AND CONFIDENTIALITY

You are hereby assured about your privacy. Privacy of subject will be respected and any information about you or provided by you during the study will be kept strictly confidential.

AUTHORIZATION TO PUBLISH RESULTS

Results of the study may be published for scientific purposes and/or presented to scientific groups, however you will not be identified; neither will your privacy be breached.

STATEMENT OF CONSENT

I, _____, do hereby volunteer and consent to participate in this study being conducted by Dr. R Ragavanandam. I have read and understood the consent form / or it has been read and explained to me. The study has been fully explained to me, and I may ask questions at any time.

Signature / Left Thumb Impression of the Volunteer Date:

Signature and Name of witness Date:

xggbj y;gotk;

bgah; :
ghypdk; :
Kfthp : taJ :

muR nfhit kUj;Jtf;fy;Yhpay/ bghJ kUj;JtJiwapy/ gl;l nkwgogg[gapYk; khzth; **,uh.uhfthdejk;** mth;fs; nkwbfhs;Sk;"**if vYkgpd;j iy kwWk;fGj;J gFjp Kwtpw;F gpyh!;vd;Dk;jfL kwWk;Mzpnrhejj cgfuzk;itj;J mWit rpfpr;ir bra;J ,Wjp fl;l braygh|L tpist[mwpjy;**" vdw nrhjidapd; bra;Kiw kwWk; midj;J tpgu';fisak; nfl;Lfbfhz;lJld/ vdJ midj;J renjf';fisak; bjspthggLj;jpfbfhz;nld;vdgij bjhptpj;Jf;bfhs;fpnwd;

ehd; ,ej Ma;tpy; KG rkkjj;JlDk/ Ra rpejida[lDk; fye;J bfhs;s rkkjpf;fpnwd;

,ej Ma;tpy; vd;Dila midj;J tpgu';fSk; ghJfhf;fggLtJld/ ,jd;Kot[fs; Ma;tpjHpy;btspaplggLtjpy; vdf;F vejj Mlnrgidak; ,y;iy vdgij bjhptpj;Jf; bfhs;fpnwd; vejj neuj;jpYk; ,ej Ma;tpy; ,Uej;J tpyfpfbfhs;s vdf;F chpik czL vdgijak;mwpntd;

,lk;:
njjp : ifbahggk;/ nuif

SL.NO	Patient Name	Age/Sex	Mode of Injury	Side	Parts/Type	Smoker	Co-Morbidity	Open/Closed	Associated Fracture	Day of surgery	Approach	Blood Loss (ml)	Duration (min)	Radiological evaluation	Complication	Flexion (°)	Extension(°)	Internal rotation (°)	External rotation (°)	Constant score
1	Maniyan	53/M	Self fall	Right	2S		Non unio	Closed	Nil	5	DP	150	120	-	Avascular necrosis	120	90	50	40	62
2	Gnanaprakash	24/M	Fall from height	Right	4	-	Nil	Open	Nil	16	DP	300	150	Union	COM	90	90	50	70	75
3	Rajan	53/M	Road traffic accident	Right	4	-	Nil	Closed	Nil	30	DP	200	90	Nil	Nil	-	-	-	-	-
4	Thulasiyammal	50/M	Road traffic accident	left	4	-	Nil	Closed	NOF	14	DP	250	130	Nil	Nil	90	90	60	40	57
5	Ayyavu	45/M	Road traffic accident	Right	4	-	DM	Closed	Nil	31	DP	200	90	Collapse	Failure of fixation	-	-	-	-	-
6	Jeyalakshmi	43/F	Road traffic accident	Right	4	-	RA	Closed	Nil	4	DP	150	155	Nil	screw perforation	100	90	50	40	60
7	Veran	66/M	Self fall	Right	4	-	CAHD	Closed	Nil	26	DP	200	126	Nil	Nil	-	-	-	-	-
8	Ponnusamy	45/M	Road traffic accident	Right	3	S	NIL	Closed	Nil	14	DP	300	120	Nil	Nil	160	160	70	70	82
9	Muthulakshmi	53/F	Fall injury	Right	3	-	Nil	Closed	Nil	3	DP	250	90	Nil	Nil	160	160	70	70	79
10	Kaliammal	65/F	Fall injury	left	3	-	Nil	Closed	Nil	8	DP	300	90	Nil	Nil	120	90	50	40	60
11	Ravishankar	18/M	Fall from height	Right	2S	-	Nil	Closed	Nil	2	DP	150	90	Nil	Nil	160	180	70	90	92
12	Shantha	60/F	Road traffic accident	Right	4	-	Nil	Closed	Nil	4	DS	200	120	Nil	Nil	160	160	70	50	81
13	Lakshmanan	60/M	Fall injury	left	3	-	Nil	Closed	Nil	4	DS	200	120	Collapse	Avascular necrosis	50	50	40	40	38
14	Ravichandran	45/M	Animal attack	Right	3	-	HTN	Closed	Nil	21	DS	200	90	Nil	Nil	90	70	40	50	56
15	Yesunathan	44/M	Road traffic accident	Right	3	S	NIL	Closed	Nil	26	DP	350	110	Nil	Nil	170	120	70	80	91
16	Thomas	38/M	Fall from height	Right	2	S	NIL	Closed	Nil	8	DP	100	90	Nil	Nil	170	120	70	80	90
17	Kalimuthu	35/M	Fall from height	left	3	S	NIL	Closed	Dislocation	25	DP	150	120	Nil	Nil	90	90	50	70	61
18	Selvaraj	50/M	Road traffic accident	left	4	s	NIL	Closed	Nil	14	DS	200	100	Nil	Nil	80	80	50	40	52
19	Rasammal	55/F	Fall injury	Right	4	-	NIL	Closed	Nil	7	DP	200	90	Nil	Nil	50	50	40	40	40
20	Pappusamy	48/M	Fall injury	left	4	-	NIL	Closed	Nil	7	DP	200	70	Nil	Nil	80	80	50	60	55
21	Gowtham	20/M	Road traffic accident	left	3	-	NIL	Closed	Nil	14	DP	100	60	Nil	Nil	-	-	-	-	-
22	Gnanapalam	45/M	Road traffic accident	left	2T	-	NIL	Closed	Dislocation	7	DS	50	50	Nil	Nil	70	70	40	50	56